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NDE Detectability of Fatigue-Type Cracks in High-Strength Alloys

NDI Reliability Assessments

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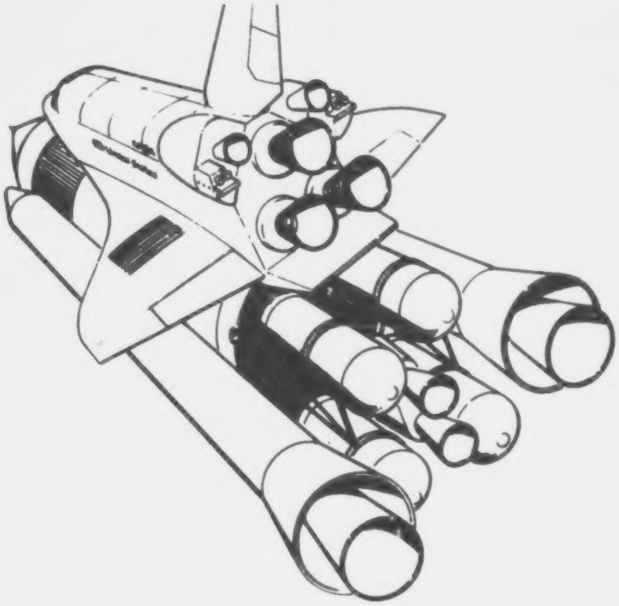

MARTIN MARIETTA

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NDE Detectability of Fatigue-Type Cracks in High-Strength Alloys

NDI Reliability Assessments

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NDE DETECTABILITY OF FATIGUE-TYPE CRACKS IN HIGH-STRENGTH ALLOYS

NDI RELIABLITY ASSESSMENTS

By Brent K. Christner,
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SUMMARY

This program was conducted to generate quantitative flaw detection capability data for the nondestructive evaluation (NDE) techniques typically practiced by aerospace contractors. Inconel 718 and Haynes 188 alloy test specimens containing fatigue flaws with a wide distribution of sizes were used to assess the flaw detection capabilities at a number of contractor and government facilities.

During this program 85 inspection sequences were completed presenting a total of 20,994 fatigue cracks to 53 different inspectors. The inspection sequences completed included 78 liquid penetrant, 4 eddy current and 3 ultrasonic evaluations. The results of the assessment inspections are presented and discussed in this report.

From the substantial data base that was generated, the minimum crack size that can be reliably (90% probability, 95% confidence level) detected by the different inspection processes assessed was estimated and will be used to update previous flaw detectability assumptions such as those contained in MSFC-STD-1249, "Standard NDE Guidelines and Requirements for Fracture Control Programs". Nominal detectability limits for a number of liquid penetrant inspection procedures are provided within this report.

In generating the flaw detection capability data base, procedures for data collection, data analysis, and specimen care and maintenance were developed, demonstrated, and validated. The data collection procedures and methods that evolved during this program for the measurement of flaw detection capabilities and the effects of inspection variables on performance are discussed.

The Inconel 718 and Haynes 188 test specimens that were used in conducting this program and the NDE assessment procedures that were demonstrated, provide NASA with the capability to accurately assess the flaw detection capabilities of specific inspection procedures being applied or proposed for use on current and future fracture control hardware programs.

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FOREWORD

This report was prepared by Martin Marietta Astronautics Group under contract NAS8-35503. The described program was initiated by NASA, George C. Marshall Space Flight Center (MSFC) under the direction of Mr. John Knadler to generate quantitative nondestructive evaluation (NDE) flaw detection capability data for the NDE techniques typically practiced by aerospace contractors. The NDE capability data was generated by surveying industry practices and capabilities using fatigue flawed Inconel 718 and Haynes 188 test specimens. The work described was completed between November 1983 and September 1988.

Mr. Ward D. Rummel of Martin Marietta Astronautics Group served as program manager and scheduled and coordinated the assessments with the participating facilities. Mr. Brent K. Christner was the program technical director and was assisted by Messrs. Donald L. Long, Steven J. Mullen, and Robert E. Muthart in conducting the industry NDE capability assessments. Specimen maintenance, data analysis, and program documentation were performed by Messrs. Christner and Long.

We wish to express our thanks to all of the contractors that volunteered their facilities and manpower for the performance of this program. Their help, cooperation, and patience during the many hours spent coordinating and conducting the data collection is appreciated. The NDI Reliability Assessment program would not have been possible without the sacrifices and contributions made by these contractors.

We would also like to express our gratitude to the inspectors that participated in this program. These individuals are ultimately responsible for the success of this program by their diligence and dedication in completing the inspection sequences described in this report. Their cooperation, skill, and integrity are appreciated.

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1.0 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Fracture control for the Space Shuttle program has been assured through the use of a combination of (1) linear elastic fracture mechanics for hardware design and analysis, and (2) the application of nondestructive inspection (NDI) for initial hardware acceptance and for determining the suitability of hardware for continuing service. Critical flaw sizes have been established for Space Shuttle and other space program hardware by careful analysis of loads and load interactions, material properties, and service environments. Although considerable effort has been devoted to obtaining the basic material property data needed to support the fracture mechanics analysis, much less has been known about the capabilities of the nondestructive evaluation (NDE) procedures being applied, particularly in manufacturing and maintenance environments. Yet, quantitative knowledge of the flaw detection capabilities of the NDE techniques is vital to the effective management of the hardware. This type of information must be available for establishing cost effective, yet safe, maintenance and inspection schedules and for making hardware retirement decisions.

In an effort to obtain much needed NDI flaw detection capability data, Marshall Space Flight Center (MSFC) initiated a program with Martin Marietta Astronautics Group in 1983 to assess and provide a quantitative measure of the flaw detection capabilities and reliability of NDI procedures as they are applied on Space Shuttle hardware during manufacture and subsequently during overhaul by National Aeronautics and Space Administration (NASA) contractors. The necessary data was acquired by visiting NASA contractor facilities identified by MSFC and evaluating the inspection procedures being applied using test specimens containing fatigue cracks with a wide distribution of sizes. This report documents the approach used, the results obtained and the conclusions and recommendations made as a result of this program.

1.2 CONTRIBUTION OF NDE TO THE MANAGEMENT OF DAMAGE TOLERANT DESIGNS

The use of linear elastic fracture mechanics in establishing and managing a damage tolerant (fail-safe) design such as that being used for the Space Shuttle program requires that the following data be generated (Ref. 1-1):

1) Development of reliable inspection procedures, taking into account the geometry and accessibility of the structure and the environment under which the inspection is to be conducted,
2) Determination of the minimum reliably detectable crack size for the inspection procedure being applied,
3) Prediction of the residual strength of the structure in a cracked condition,

4) Determination of the critical crack length at which the fail-safe load exceeds the residual strength,
5) Establishment of the expected service load profile,
6) Determination of the crack propagation curve,
7) Analysis of the structure to determine the locations liable to develop cracks.

The interrelationship of these factors is shown in Figure 1-1. The crack growth rate curve (top) plots crack size as a function of time based on the anticipated service load profile. Underneath this curve is the corresponding residual strength curve which shows the reduction in residual strength with time as the crack growth occurs. Point A on these curves corresponds to the crack size at which the defect becomes detectable with a high degree of reliability for the specific type of inspection being applied. Point B is the point at which the residual strength has decreased sufficiently so that it now equals the fail-safe load.

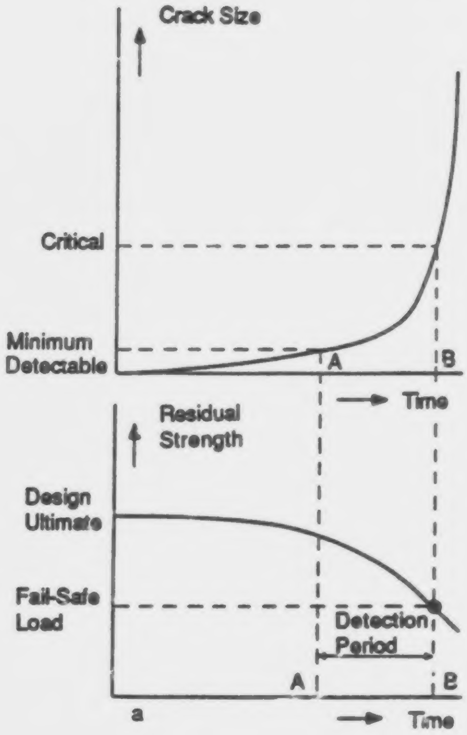

Figure 1-1
Crack Growth Rate and Residual Strength Curves Showing the Dependence on NDI to Provide Safe-Life

The detection capability of the inspection procedure applied by the manufacturer must be known with some degree of accuracy to establish the initial placement of Point A on these curves. The time between Point A and Point B then becomes the period available for detection of cracks which may propagate in service before they reach a critical size. For added safety, two or more inspection cycles are commonly scheduled within the available crack detection period. The detection capability of the maintenance inspection results in the re-establishment of the position of Point A if it differs from the capability of the original inspection performed prior to entering service.

Based on this type of analysis it becomes readily apparent that quantitative knowledge of the detection capabilities of both the original and in-service inspection procedures is vital to establishing maintenance and inspection schedules for hardware designed using linear elastic fracture mechanic techniques.

1.3 PROGRAM OBJECTIVES

The first objective of the NDI Reliability Assessment program was to generate the data necessary to determine the minimum size crack-like flaws that can be reliably detected by the NDE techniques typically practiced by aerospace contractors on high-temperature super alloys such as those employed for liquid propulsion engines. The data generated during this program will in turn be used to update and validate the flaw detectability assumptions contained in MSFC-STD-1249, "Standard NDE Guidelines and Requirements for Fracture Control Programs" (Ref. 1-2). This document and the data produced by this program will be used by NASA to support the management of fracture control hardware programs such as Space Shuttle, Space Telescope, Space Station, and numerous payload/experiment programs. In addition, the flaw detection capability data provided by this program will be used as a basis for design parameters for future fracture control hardware programs.

A second objective and a direct result of the data collection was the development, demonstration and validation of the procedures required to conduct quantitative assessments of production inspection capabilities using the Inconel 718 and Haynes 188 test specimens produced under contract NAS8-34425 (Ref. 1-3). The assessment procedures validated as a result of this program included:

1) Data collection techniques,
2) Data analysis methods for quantification of inspection performance,
3) Specimen care and maintenance.

The large number of inspection opportunities provided by this program allowed the development and refinement of the techniques necessary to measure and demonstrate the effects of subtle processing variations on inspection performance and increased the value of the data base generated.

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1-2. National Aeronautics and Space Administration. Standard NDE Guidelines and Requirements for Fracture Critical Hardware. MSFC-STD-1249, George C. Marshall Space Flight Center, September 11, 1985.

1-3. Brent K. Christner and Ward D. Rummel: NDE Detectability of Fatigue-Type Cracks in High-Strength Alloys. NASA CR-170817, July 1983.

2.0 PROGRAM APPROACH

The task of assessing NDI capability and reliability is complex in nature and has resulted in the continuing refinement of techniques as critical test parameters are identified and better understood. The basis for all quantitative NDI capability assessments is the passing of representative test specimens containing known and well characterized flaws of varying sizes and locations through an inspection process and assessing the overall flaw detection capabilities as a function of flaw size. The assessments completed during this program were performed using fatigue cracked Inconel 718 and Haynes 188 test specimens produced for MSFC by Martin Marietta Astronautics Group under contract NAS8-34425 (Ref. 2-1). These specimens were constructed to contain fatigue cracks with a wide distribution of flaw sizes in sufficient numbers to allow for a statistically valid assessment of detection capabilities. The specimens were designed to be effective for the evaluation of most of the commonly applied inspection techniques used on the Space Shuttle program. The inspection procedures assessed during this program included liquid penetrant, eddy current and ultrasonic methods. In addition to these methods, a cursory assessment was made of the ability of x-radiography to detect the fatigue cracks contained in the Inconel 718 and Haynes 188 specimens. However, the aspect ratios of the cracks in the specimens were found to be not sufficiently large for reliable detection by traditional x-radiographic techniques and a thorough examination of detection capabilities was not pursued.

2.1 ASSESSMENT LOGISTICS

Those contractor facilities contacted to participate in the assessment program were coordinated with MSFC. Once a commitment to participate in the program was obtained, a single point of contact at the contractor facility was identified and the schedule for the assessment was formalized. Prior to entry into the contractor facilities for the on-site data collection, logistics for performance of the assessments were arranged by telecon or by a visit to the facility. Those items of primary concern arranged prior to entry into the contractor facility for data collection included:

1) Logistics for entry including personnel badging, storage area for the test specimens and support equipment, work shift times, parking etc.;
2) Arrangements for test specimen cleaning capability; (For those facilities which did not have adequate cleaning facilities available for use during the assessment, a high-power ultrasonic-cleaner/vapor-degreaser unit was shipped to the contractor facility for use. In this event, the electrical power and overhead hoist requirements were arranged prior to entry into the facility for data collection.)
3) Schedule and arrangements for management, line supervision and operator in-briefings;

4) Identification of the inspection techniques and procedures to be assessed;
5) Scheduling of the inspector personnel for performance of the assessment inspection sequences.

During the program planning for each location, the inspection procedures, calibration methods, acceptance criteria, and personnel training program were evaluated for use in finalizing the facility entry and data acquisition plan.

2.2 ASSESSMENT PREPARATIONS

In preparation for the on-site assessments, arrangements were completed so that the data collection could be performed smoothly with as little disruption as possible at the data collection site. Reusable shipping containers were used for shipment of the test specimens, operating supplies and the microcomputer system.

The Inconel 718 and Haynes 188 test sets were thoroughly cleaned and examined to insure that the panel serial numbers were clearly visible prior to packing for shipment. Specimen processing racks specially fabricated to facilitate specimen handling during inspection processing and specimen cleaning were shipped with the specimens for use during the assessment. Each rack contains openings for up to eight specimens and are designed to be used for batch processing the specimens or to aid in handling when the test specimens are to be individually processed.

The ultrasonic-cleaning/vapor-degreasing unit with the necessary cleaning solvent was shipped to those facilities where adequate cleaning capability was unavailable to clean the test specimens per the procedures developed under Contract NAS8-34425 (Ref. 2-1). The test specimens were cleaned between each penetrant inspection sequence to insure complete penetrant material removal. This was done to prevent degradation of the specimens through contamination and to insure the presentation of test specimens to each inspector that were in a pristine (clean) condition.

Arrangements were made in advance to provide space for securing the test specimens and office space was made available for setting up the microcomputers to perform the on-site data analysis.

2.3 ON-SITE DATA COLLECTION

2.3.1 Management/Supervision In-Briefing

Upon entry into a contractor facility, a management and line supervision in-briefing was held to explain the purpose and scope of the assessment program. The number of inspection sequences to be completed and the requirements for inspection personnel were outlined. Feedback was obtained from the facility personnel on what information they would like

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to gain from the assessment and if possible arrangements were made to provide the desired information. An outbriefing was scheduled to be held with management and supervision personnel upon conclusion of the assessment at which time the observations, findings and preliminary data analysis results would be presented.

2.3.2 Instructions to the Operators

The inspectors used for performance of the assessment inspections were selected from the current skill certification list at each facility. Prior to beginning the inspection sequences, the inspectors were briefed using a sound-slide presentation on the purpose and value of the program and given basic instructions for performing the inspections. Figure 2-1 shows two inspectors viewing the slide presentation prior to their participation in the program.

Figure 2-1
Two Inspectors Viewing Slide Orientation Presentation

Each inspector was asked to fill out a profile form to provide a record of his/her education, training, and experience related to NDI that could be correlated with the inspection results. However, care was taken to prevent the identification of a particular data set with an individual inspector. Inspector names were not recorded, and the inspectors were not identified on the data provided to the facilities participating in the assessments.

The inspectors participating in the program were asked to process the test specimens as uniformly as possible utilizing the inspection materials, processes and operating procedures in use at the contractor facility for production inspections. The test specimens were tracked through all processing steps for each inspection sequence by an Martin Marietta engineer to (1) verify and document the processing steps used, (2) evaluate the individual processing steps and look for possible areas for process improvement, (3) observe the consistency and variables in the process application, and (4) insure the well being of the test specimens. Figures 2-2 through 2-5 show inspectors processing the specimens through penetrant application, penetrant removal, drying and developer application.

2.3.3 Independent Penetrant Process Assessment

In addition to the actual detection capability data collected from the penetrant inspection sequences completed, an independent assessment of the performance of penetrant processes was made by processing PSM-5 or SunRise Corp. Type II cracked chrome panels with the test specimens during each inspection sequence. Figure 2-6 shows a Martin Marietta engineer evaluating a PSM-5 specimen that had been processed with the Inconel 718 specimens that are shown being inspected.

Figure 2-2 Application of Penetrant to Test Specimens

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Figure 2-3 Removal of Penetrant from Test Specimens

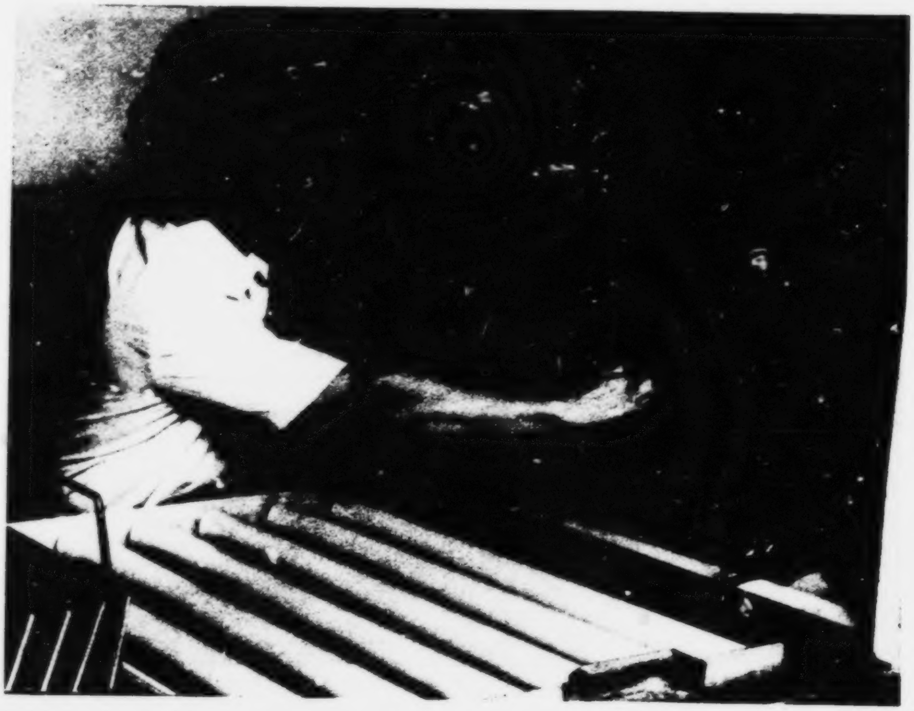

Figure 2-4 Inspector Pushing Test Specimens into Drying Oven

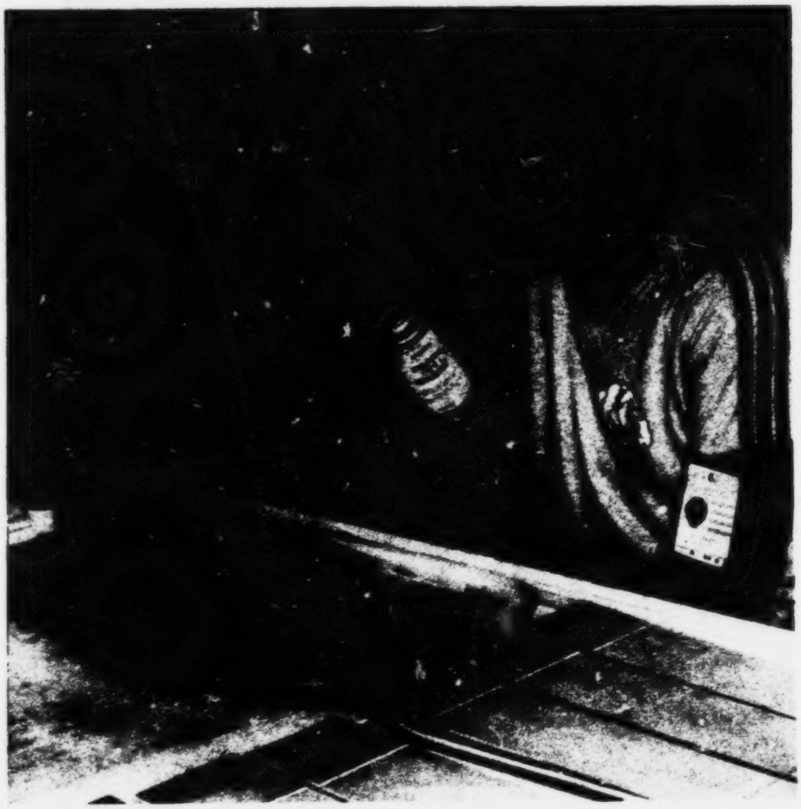

Figure 2-5 Application of Developer to Test Specimens

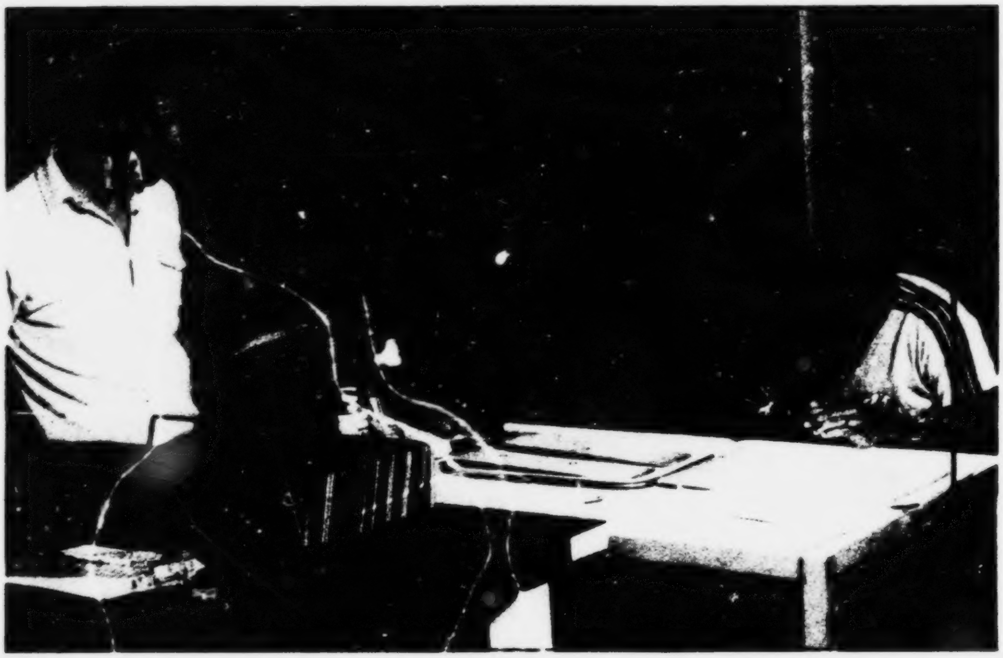

Figure 2-6
Evaluation of PSM-5 Cracked Chrome Panel During Inconel 718 Inspection

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Ultraviolet light intensity and background white light intensity measurements were taken during each penetrant inspection sequence. Samples of all penetrant materials used in the performance of inspection sequences were taken for an off-line assessment of performance at the Martin Marietta Astronautics Group facilities in Denver.

2.3.4 Inspection Documentation Procedures

The inspectors were instructed to inspect the specimens as if they were production hardware and use the same diligence and judgment that they use in production for locating and interpreting flaw indications. A Martin Marietta engineer observed each inspector for techniques, habits and tendencies which may have effected performance and noted these on the inspection data sheets. Figure 2-7 shows a Martin Marietta engineer observing the inspection of a set of test specimens. The inspectors marked each flaw identified on the specimens and the Martin Marietta engineer determined the coordinates by placing a clear acetate grid over the panel surface and documenting the location of each flaw found on an inspection data sheet. Figure 2-8 shows a diagram of the coordinate grids utilized. A separate grid was used for the front (A) and back (B) sides of the panels as shown.

Figure 2-7
Observation of Test Specimen Inspection By Martin Marietta Engineer

the microcomputer systems being used for entry of inspection data and the generation of a POD curve at one of the assessment sites. Upon conclusion of the assessment, the POD curves were presented at an out-briefing held with facility management personnel. At the out-briefing the preliminary assessment results were presented in the form of the POD curves, comments based on the direct observations of the assessment personnel, and recommendations for improving inspection performance.

2.3.6 Specimen Cleaning and Maintenance

Reusable polyethylene shipping containers were obtained for protection of the test specimens during storage and shipment to the assessment sites. Prior to shipment and then immediately after each penetrant inspection sequence, the test specimens were cleaned ultrasonically in a high-power ultrasonic cleaner/degreaser containing Freon TF or Freon TMC. The specimens were cleaned for as long as the facility assessment schedule would permit but in no case for less than 4 hours before being reprocessed and inspected. Following each assessment, the specimens were cleaned for a minimum of 8 hours before being stored. This cleaning procedure was developed during NASA contract NAS8-34425 (Ref. 2-1) and was demonstrated to be effective for maintaining fatigue flawed test specimens during the Air Force Integrated Blade Inspection System (IBIS) penetrant inspection capability assessment (Ref. 2-2). Figure 2-10 shows a load of test specimens being lowered into the ultrasonic cleaner that was shipped to the assessment sites for specimen cleaning.

Figure 2-9
Microcomputer Systems used for On-Site Data Entry and Analysis

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Figure 2-10
Load of Test Specimens Being Lowered into the Ultrasonic Cleaner Shipped to the Assessment Sites

A running tally of inspection results on a crack by crack basis was maintained during the course of the assessment program to look for trends indicating that crack detectability may have been deteriorating due to panel contamination. The crack tallies showed no indications of specimen degradation occurring using these cleaning procedures.

2.3.7 Assessment Reporting

Upon conclusion of each assessment, an engineering report was prepared for the exclusive use of personnel at the facility visited. The facility reports included POD curves for each inspection sequence completed plus any additional analysis that was felt necessary to fully describe the inspection performance demonstrated. Included in the reports were the direct observations made by the assessment personnel and recommendations for improving overall flaw detection capability. Results of the performance of individual inspection personnel were not provided.

REFERENCES

2-1. Brent K. Christner and Ward D. Rummel: NDE Detectability of Fatigue-Type Cracks in High-Strength Alloys. NASA CR-170817, July 1983.

2-2. Ward D. Rummel, Brent K. Christner, Steven J. Mullen, and Donald L. Long: Characterization of IBIS Fluorescent Penetrant Inspection Capabilities. SA-ALC/MMEI/3/86, Novemeber 1986.

3.0 INCONEL 718 AND HAYNES 188 TEST SPECIMENS

The test specimens used for conducting the NDI reliability assessments were produced by Martin Marietta Astronautics Group under contract NAS8-34425 (Ref. 3-1). Two sets of test specimens were constructed, one from 1/4 in. thick Inconel 718 (AMS 5596C) plate and the other from 1/4 in. thick Haynes 188 (AMS 5608A) plate, both materials in the annealed condition. The plate material was cut into 16 x 4 x 1/4 in. specimens, oriented both transverse and longitudinal to the rolling direction. Fatigue flaws were grown in random locations in the specimens with flaw lengths evenly distributed from under 0.010 to over 0.250 in., in sufficient numbers to allow for a statistically valid assessment. The flaw growth procedures used were baselined on the methods used to produce fatigue flawed specimens for previous NASA and USAF programs (Ref. 3-2, 3-3, 3-4, and 3-5).

Prior to producing the test set specimens, 40 Inconel 718 and 53 Haynes 188 development flaws were grown and broken open to validate crack growth procedures and to provide a data base from which crack depths in the actual test specimens could be estimated.

In an attempt to produce variations in the sizes and configurations of the cracks in the test specimens, the crack initiation and growth techniques were varied. The three-point bending fatigue technique used during the production of these specimens, produces a growth rate ratio of crack depth to crack length of approximately 0.5 at the specimen surface. The rate of crack depth growth relative to crack length growth then steadily decreases as the crack depth approaches the neutral axis of the bending load profile. Consequently, the aspect ratio of the finished crack is dependent on the aspect ratio of the starter notch used to initiate flaw growth and the depth to which the flaw is grown. Cracks with an aspect ratio of approximately 0.5 (before machining to remove the notch) can be grown by using a short, deep notch. Cracks with lower aspect ratios can be grown by using longer, shallower notches. Machining to remove the starter notches reduces the final crack aspect ratios proportionally to the depth of material removed.

Two different starter notch configurations were used to initiate the cracks in the test specimens. Photographs taken of two typical development flaws grown in the Haynes 188 material using the two different starter notch configurations are shown in Figure 3-1.

Using the procedures developed and validated during the growth of the development flaws, the actual Inconel 718 and Haynes 188 fatigue flawed test specimens were produced. Following crack growth, the center ten inches of each specimen were machined as shown in Figure 3-2 to remove the EDM starter notches used for flaw initiation and to provide a random machined pattern with respect to the flaw orientations. After machining, the specimens were lightly etched and penetrant inspected to insure that all flaws contained in the test set were open to the surface and detectable using liquid penetrant techniques. Flaw lengths were measured by placing the specimens back in the fatigue machine under load and measuring optically under 20X magnification.

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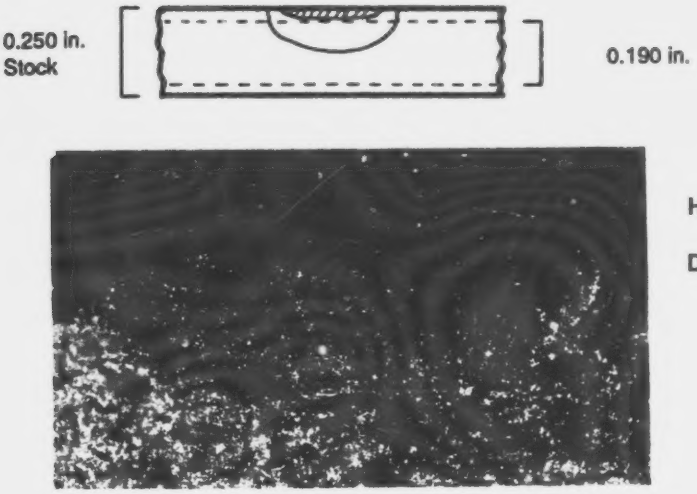
a/2c = 0.33 (Before Machining)

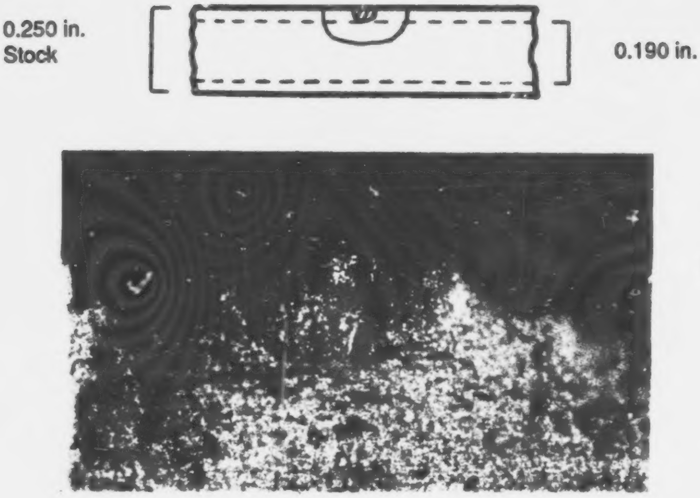

0.250 in.
Stock
0.190 in.

Haynes 188–Case A Flaw

Development Flaw # GL/1

Flaw Length–0.255 in.
Flaw Depth–0.086 in.

a/2c = 0.44 (Before Machining)


0.250 in.
Stock
0.190 in.

Haynes 188–Case B Flaw

Development Flaw # ET/4

Flaw Length–0.139 in.
Flaw Depth–0.061 in.

Figure 3-1
Side View of Crack Starter Notch Shape and Final Crack Configuration for Haynes 188 Case A and Case B Flaws

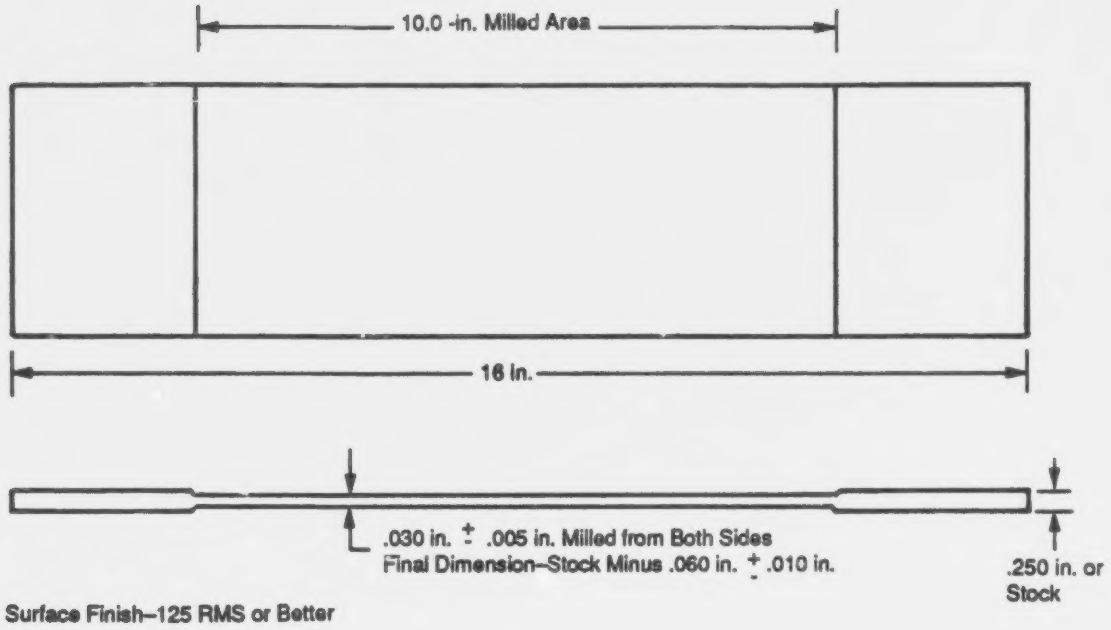

10.0 -in. Milled Area
16 in.
.030 in. ± .005 in. Milled from Both Sides
Final Dimension–Stock Minus .060 in. ± .010 in.
.250 in. or Stock
Surface Finish–125 RMS or Better

Figure 3-2
Specimen Configuration for Inconel 718 and Haynes 188 Flawed Panels

A total of 281 confirmed fatigue flaws were grown in 95 Inconel 718 panels. Fifteen unflawed panels were included at random in the panel numbering system to yield a total of 110 panels in the Inconel 718 test set. Eighty-five Haynes 188 specimens were prepared containing a total of 284 confirmed flaws. Seventeen unflawed panels were included at random in the test set to yield a total of 102 Haynes 188 specimens. For both alloys, the number of cracks per specimen was varied from one to five, with the flaws located on either the panel front or back to randomize flaw locations and number of flaws per panel. The final distribution of crack lengths for both the Inconel 718 and Haynes 188 test sets after machining are shown in Table 3-1.

Table 3-1
Test Set Flaw Distribution by
Flaw Length Range

Crack Length Range (inches)	Number of Flaws Inconel 718	Haynes 188
< 0.010	2	1
0.010 - 0.050	63	65
0.051 - 0.100	60	68
0.101 - 0.150	60	68
0.151 - 0.250	60	60
> 0.250	36	22
TOTALS	281	284

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3-1. Brent K. Christner and Ward D. Rummel: NDE Detectability of Fatigue-Type Cracks in High-Strength Alloys. NASA CR-170817, July 1983.

3-2. W.D. Rummel, P.H. Todd, S.A. Frecska, and R.A. Rathke: The Detection of Fatigue Cracks by Nondestructive Testing Methods. NASA CR-2369, February 1971.

3-3. W.D. Rummel, R.A. Rathke, P.H. Todd, T.L. Tedrow, and S.J. Mullen: Detection of Tightly Closed Flaws By Nondestructive Testing (NDT) Methods in Steel and Titanium. NASA CR-151098, September 1976.

3-4. W.H. Lewis, W.H. Sproat, B.D. Dodd, and J.M. Hamilton: Reliability of Nondestructive Inspections. SA-ALC/MME-76-6-38-1, December 1978.

3-5. W.D. Rummel, S.J. Mullen, B.K. Christner, F.B. Ross, and R.E. Muthart: Reliability of Nondestructive Inspection (NDI) of Aircraft Engine Components. SA-ALC/MM-8151, January 1984.

4.0 STATISTICAL NATURE OF INSPECTION RELIABILITY ANALYSES

Much of the NDI capability data available during the design and initial production phases of the Space Shuttle program were generated under carefully controlled laboratory environments. However, NDI capability and reliability is dependent on, and varies with, the environment in which it is conducted. Very small flaws may be revealed under ideal laboratory conditions by a given technique while very large flaws may be missed by the same technique when applied under less ideal conditions such as those found in a production or maintenance environment. In contrast to laboratory inspections, the factor of greatest importance in assessing the capability of a production fracture-critical inspection is not the "smallest flaw detected" by the given technique, but the "largest flaw missed" by the technique that may enter or remain in service. The largest flaw missed, not the number of small flaws found, is the more dominant factor in determining the capability and reliability of an inspection procedure.

Martin Marietta Astronautics Group has, through contracts with NASA (Ref. 4-1, 4-2, 4-3) and the United States Air Force (USAF) (Ref. 4-4, 4-5, 4-6), gathered and studied considerable NDI capability data collected in laboratory, production, and overhaul environments. The quantitative results and the direct observations made during these assessments have shown that in addition to the inspection environment, the factors controlling NDI process performance are:

Physics of the inspection application (flaw and material properties), Inspection selection and application.	NDI Engineering
Inspection materials, Inspection equipment, Inspection process, Human factors.	NDI Application

The physics of the material to be inspected and the flaw types requiring detection must be fully understood before the appropriate inspection technique can be selected, developed and applied. If the required NDI engineering hasn't been satisfactorily performed prior to application of the inspection procedure, the desired detection capabilities cannot be achieved regardless of the precision with which the NDI process is applied or the skills of the inspection personnel.

With a properly engineered and applied procedure, the NDI application factors become the dominant force in determining the ability of the process to detect the required defects. The human factor influence on NDI application is listed last because if the other NDI application parameters do not provide a detectable signal, the inspector performing the evaluation has little effect on the overall process performance regardless of his level of ability.

4.1 CONDITIONAL PROBABILITY

Nondestructive testing involves the measurement of complex physical parameters with inherent variations in both the measurement technique and in the test object. The output from such a measurement/decision process may be analyzed as a problem in conditional probability. When an inspection is performed, the outcome is not a simple accept/reject decision as is frequently envisioned, but is actually a case of conditional acceptance due to the interdependence of the measurement and decision responses. There are four possible outcomes resulting from an inspection process which are illustrated in the following diagram to show the conditional nature of detection probability analyses:

		INSPECTION STIMULI	
		POS a	NEG n
INSPECTOR RESPONSE	POS A	TRUE POSITIVE (Flaw Detected) M(A,a) P(A,a) (No Error)	FALSE POSITIVE (False Alarm) M(A,n) P(A,n) (Type II Error)
	NEG N	FALSE NEGATIVE (Undetected Flaw) M(N,a) P(N,a) (Type I Error)	TRUE NEGATIVE (No Flaw) M(N,n) P(N,n) (No Error)

To summarize, the possible outcomes from an inspection process are:

1) True Positive (TP) - A crack exists and is detected, where
M(A,a) = the total number of true positives and
P(A,a) = the probability of a true positive.

2) False Positive (FP) - No crack exists but one is identified, where
M(A,n) = the total number of false positives and
P(A,n) = the probability of a false positive.

3) False Negative (FN) - A crack exists but is not detected, where
M(N,a) = the total number of false negatives and
P(N,a) = the probability of a false negative.

4) True Negative (TN) - No crack exists and none is detected, where
M(N,n) = the total number of true negatives and
P(N,n) = the probability of a true negative.

The interdependence of these matrix quantities can be expressed as:

$$\underset{(TP)}{M(A,a)} + \underset{(FN)}{M(N,a)} = \underset{\text{(Total number of defects)}}{\text{Total opportunities for positive calls}}$$

and

$$\underset{(FP)}{M(A,n)} + \underset{(TN)}{M(N,n)} = \text{Total opportunities for false alarms}$$

Due to the interdependent relationship, only two independent probabilities need be considered to quantify the inspection/decision task.

The probability of detection (POD) or probability for a true positive $P(A,a)$ can be expressed as:

$$P(A,a) = \frac{M(A,a)}{M(A,a) + M(N,a)} \text{ or } \frac{\text{total true positive calls}}{\text{total number of defects}}$$

Likewise, the probability for false alarms (POFA) or the probability for a false positive $P(A,n)$ can be expressed as:

$$P(A,n) = \frac{M(A,n)}{M(A,n) + M(N,n)} \text{ or } \frac{\text{total false alarms}}{\text{opportunities for false alarms}}$$

4.2 CONDITIONS FOR DETECTION

When an NDI process is completed, the results must be interpreted as a detection (signal present) or as a nondetection (signal absent). The basis for detection is dependent on sensing and interpretation of a signal level that is above a given threshold. Sensing and interpretation are dependent on the signal (plus noise) and noise (background) levels presented to the operator.

If the inspection of a single flaw is repeated, probability density distributions for both the signal generated by the presence of the flaw and the background noise will be produced. For a large flaw (Fig. 4-1), the signal and noise distributions will be well separated, the POD will be high, and the POFA will be low. If the inspection is repeated on a smaller flaw, signal and noise probability density distributions will be generated as shown in Figure 4-2. For this flaw size, the signal and noise distributions overlap to a degree and the POD will be reduced with a corresponding increase in the POFA. If the flaw size is further reduced, the probability density distribution for signal (plus noise) and noise will be coincident as shown in Figure 4-3. The signals generated from the inspection of this flaw will be lost in the noise, the POD will be low, and the POFA will be high.

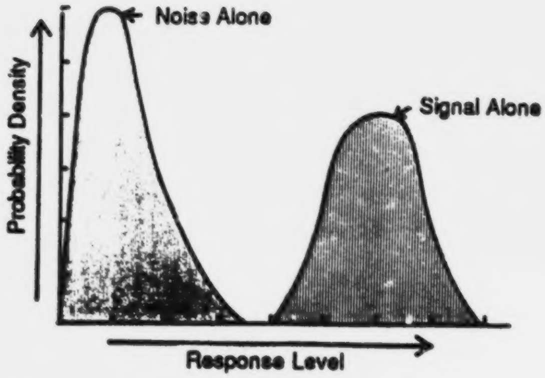


Figure 4-1
Signal/Noise Density Distributions
(Large Flaw)

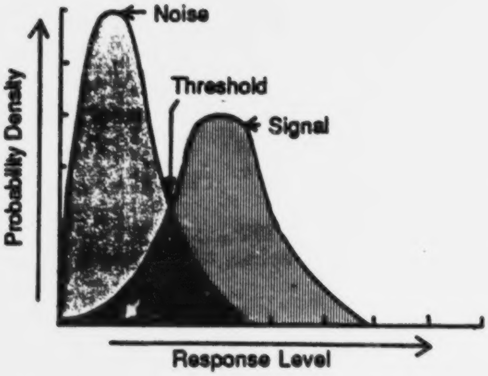


Figure 4-2
Signal/Noise Density Distributions
(Medium Flaw)

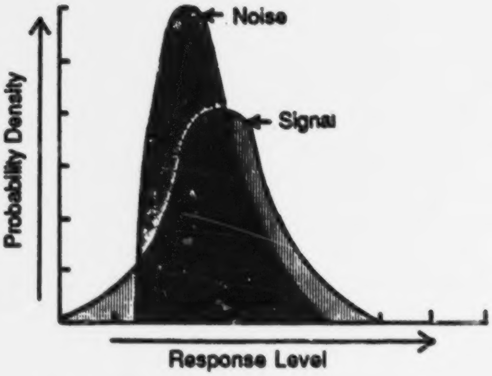


Figure 4-3
Signal/Noise Density Distributions
(Small Flaw)

From these diagrams, it is clear that the performance capability of a process is dependent on the statistical nature of the signal and noise distributions produced by the process for flaws of a given size. It is however, equally dependent on the acceptance criterion level applied to make the accept/reject decision. Consider the application of an inspection process to a large flaw producing a measurable separation between the signal and noise distributions as shown in Figure 4-4. If the acceptance criterion level used to make the accept/reject decision (represented by the vertical arrow) is placed at too high a level, some flaws will be accepted (missed). If the acceptance criterion is placed at a level that is too low, all of the flaws will be rejected, but at the expense of some false calls (rejection of good parts). If the acceptance criterion is properly placed between the signal and noise distributions, clear discrimination of actual flaw signals from background noise will result with a high POD and a low POFA.

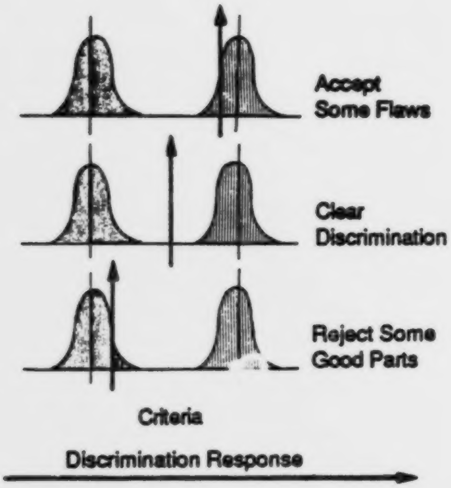


Figure 4-4
Influence of Acceptance Criterion
(Vertical Arrow) on Process Discrimination

4.3 PROBABILITY OF DETECTION

The statistic of primary interest in describing the performance of production and maintenance inspection processes is the probability of detecting defects which will prove to be critical to the operation of the hardware being inspected. A valid statistical method of defining inspection performance is to specify percent probability (p_I) at a given confidence level (G) for a crack of a given size. The values for p_I and G commonly used for NDI reliability demonstrations have been 90% POD with 95% confidence to be consistent with MIL Handbook No.5 B value requirements.

The determination of detection capability for a flaw of a given size during early demonstrations was performed using a binomial distribution analysis. Experimental data were collected by submitting a sample of flaws of near equal size to an inspection process and recording the outcome. The sample size of flawed parts required to estimate the lower-bound probability with a specified confidence is determined from the following equation:

$$G = 1 - \sum_{x=s}^{N} \binom{N}{x} (P_l)^{x} (1-P_l)^{N-x} \qquad [4-1]$$

where G = confidence level,
N = sample size,
S = the number of sucesses (flaws detected),
p_l = the POD given G.

By specifying the confidence level (G) as 95% and the lower bound probability (p_l) as 90%, a set of values for sample size (N) and number of successes (S) can be calculated. Each combination of N and S which satisfies Equation 4-1 indicates the number of inspections and the number of detections required to achieve the specified 90% probability at the lower 95% confidence bound. Listed below are several solutions to Equation 4-1 for N and S given G = 0.95 and p_l = 0.90.

90% Probability/95% Confidence Level:

29 successes in 29 trials
45 successes in 46 trials
59 successes in 61 trials
72 successes in 75 trials
85 successes in 89 trials
98 successes in 103 trials

The binomial distribution analysis is an effective means for qualifying inspection personnel to a specific flaw detection requirement. This type of single point description of NDE capability is useful for many engineering applications, but for life cycle management of fail safe design hardware, a functional relationship between POD and crack size is required. This requirement has lead to the expenditure of much effort in the generation of data and development of analytical techniques to describe flaw detection performance as a function of flaw size by means of the POD curve (Fig. 4-5). Some of the analytical techniques that have been used to generate POD curves from experimental data include the moving average (binomial grouping) method (Ref. 4-6), the maximum likelihood method (Ref. 4-7) and the Probit method (Ref. 4-8). For inspection processes that produce quantitative signal data, the signal response ($\hat{a}$) versus flaw size (a) method (Ref. 4-7) is available for POD curve generation. The POD curve presents the discriminating capability of an inspection process as a function of flaw length and provides a convenient method for comparing the performance of inspection processes.

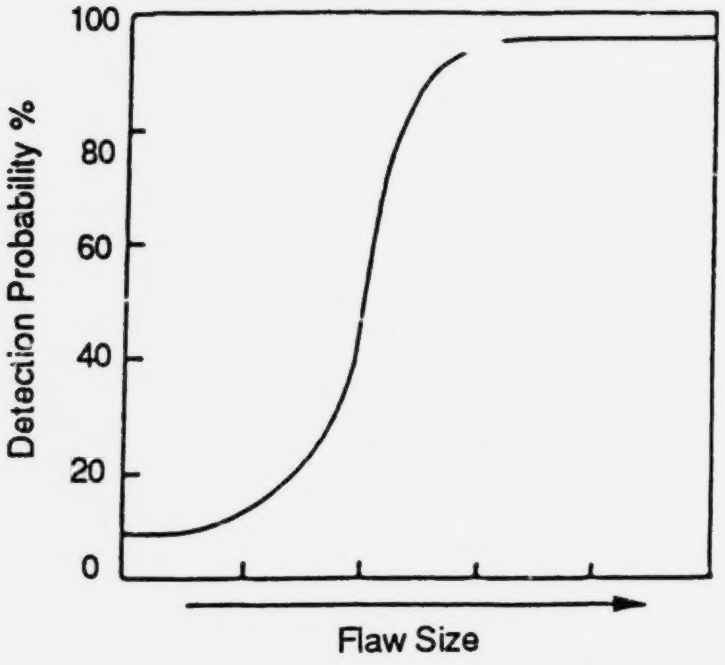


Figure 4-5
Typical Probability of Detection Curve

4.3.1 Moving Average Method of Analysis

The moving average (binomial grouping) method of analysis for POD curve generation was developed by Rummel et al (Ref. 4-1) in 1971 and has been the most widely applied of the available methods. The moving average technique generates a POD curve by first sorting the cracks and corresponding inspection outcomes by length from longest to smallest and then grouping them to provide a statistically significant sample size for analysis. For instance a 29 crack sample would be used for a 90% probability/95% confidence level analysis based on the binomial distribution described above. Starting with the 29 largest flaws in the data set, the point estimate of detection for the sample group is calculated by dividing the total number of flaws detected by the total number of opportunities (29). The point estimate of detection is plotted at the selected (largest, median, or smallest) flaw size in the 29 crack sample with the corresponding lower confidence bound value calculated using Equation 4-1. Since it can be argued that each NDI observation is independent, successive 29 crack samples can be formed by dropping the largest flaw from the previous sample and adding the next (largest) flaw from the remaining data base. This process is repeated until all flaws in the data base have been considered. A curve can then be fit to the point estimate points calculated using the log logistic transformation and linear regression technique described in Appendix A.

The moving average method of analysis has proven to be an effective means of characterizing and presenting inspection performance data. Application of the method requires a large data base generated from the use of flawed test specimens having a flaw size distribution that bounds the threshold detection capability for the process being assessed. The majority of flaws used to generate the data base should be of a size near the threshold detection capability of the process in order to provide maximum sampling opportunites in the region of the curve where the transition from detection to nondetection occurs.

4.3.2 Maximum Likelihood Method of Analysis

The maximum likelihood method of plotting the POD function does not require the grouping of data as do the methods based on the binomial distribution, but is based directly on the observed outcomes of 0 for a non-detection (miss) and 1 for a detection. Using this method, POD curves are generated by using the maximum likelihood method of regression to estimate log logistic model parameters for the POD function. The maximum likelihood method converges to those parameters which maximize the probability of obtaining the observed data using an iterative process. The log logistic model for POD is as follows:

$$[4\text{-}2] \qquad \mathrm{POD}(a) = \frac{\exp[\alpha + \beta \ln(a)]}{1 + \exp[\alpha + \beta \ln(a)]}$$

where a = crack length

The maximum likelihood estimates of the logodds model parameters, α and β, are calculated by satisfying the following simultaneous equations.

$$[4\text{-}3] \qquad 0 = \sum_{i=1}^{n} n_i p_i - \sum_{i=1}^{n} \frac{n_i \exp[\alpha+\beta \ln(a_i)]}{1+\exp[\alpha+\beta \ln(a_i)]}$$

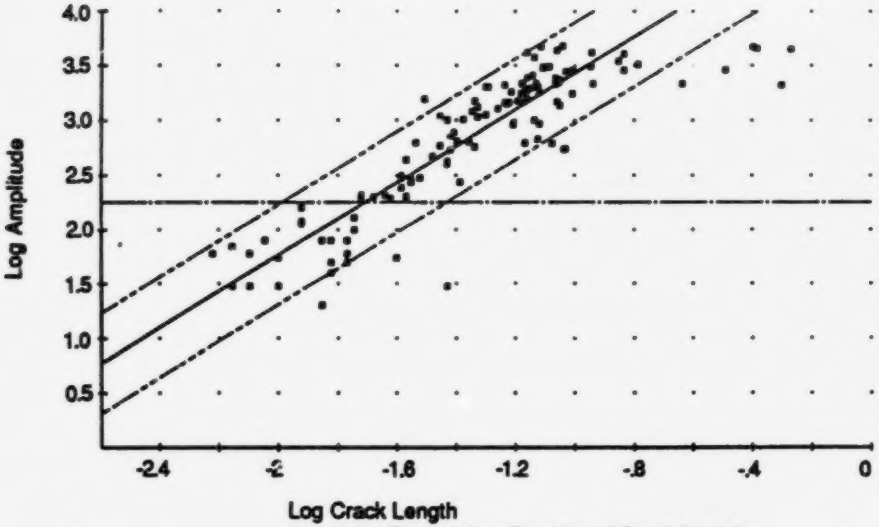
$$[4\text{-}4] \qquad 0 = \sum_{i=1}^{n} n_i p_i \ln(a_i) - \sum_{i=1}^{n} \frac{n_i \ln(a_i) \exp[\alpha+\beta \ln(a_i)]}{1+\exp[\alpha+\beta \ln(a_i)]}$$

where p_i = 1 if the flaw was detected and p_i = 0 if the flaw was not detected for single inspection data and p_i equals the proportion of times an individual crack was detected for combined inspection data, and n_i equals the number of times the i_{th} crack was inspected.

Because the maximum likelihood method does not require the grouping of data, this method permits the use of fewer data points than does the moving average method and is less dependent on the distribution of flaw sizes used to generate the data. However in cases where the experimental data deviates from the log logistic model, the method does not always produce a definitive solution. For selected data sets, the maximum likelihood and moving average methods of analysis have been shown to produce nearly identical results (Ref. 4-9) when used to plot the same data sets.

4.3.3 $\hat{a}$ versus a Method of Analysis

For inspection processes that produce quantitative and discrete signal outputs, the POD function can be generated using the relationship between the flaw signal ($\hat{a}$) and the actual flaw size (a). The $\hat{a}$ versus a method developed by Berens and Hovey (Ref. 4-7) for application to inspection capability data, generates the POD function by recording actual inspection response levels from cracks of varying size and plotting to determine the functional relationship between signal amplitude and crack size. The log/log (or log normal) function has been found to be representative of this relationship for many inspection processes. A sample plot of signal amplitude as a function of crack length is shown in Figure 4-6. Once the functional relationship between the signal amplitude and flaw size has been established, the data is transformed to a linear relationship and regression analysis is applied to determine a best fit line through the inspection data. Confidence bounds are calculated for the regression line and the inspection acceptance criterion is plotted as shown in Figure 4-6. The probability of detection (POD) as a function of crack size is then determined by integrating the portion of the response distribution which exceeds the acceptance threshold level as the crack size increases.



Amplitude Plotted As a Function of Crack Length

Figure 4-6
Plot of Signal Amplitude As a Function of Crack Length on a Log Normal Scale for an Eddy Current Bolt Hole Inspection Procedure

Assumptions that are inherent to the successful application of the $\hat{a}$ versus a method are (1) the response/crack size relationship can be modeled and made linear through data transformation, (2) the repetitive response distribution from a single crack and response distribution from multiple cracks of equal size are normally distributed, and (3) the response variation (error) distributions are equal for the range of flaw sizes sampled.

The $\hat{a}$ versus a method of analysis allows calculation of the POD directly from the inspection signal amplitude and the acceptance threshold applied. A primary advantage of this method is that it allows the generation of POD curves at different acceptance threshold levels without the need to recollect data for each threshold examined. The $\hat{a}$ versus a method has been shown to be slightly less conservative than the moving average and maximum likelihood methods (Ref. 4-3).

4.4 INSPECTION DISCRIMINATION ANALYSIS

While POD curves have been a primary means of describing inspection capability, they provide no information on the ability of an inspection process to discriminate actual flaw signals from background noise or false indications. A high POD is of little value if it is obtained at the expense of a high false call rate. Two methods of analysis are available which have been applied to evaluate the relationship between POD and POFA. These include the relative operating characteristic (ROC) curve and the threshold diagram.

4.4.1 ROC Analysis

The ROC method of analysis as applied to inspection capability data was derived from the techniques used to quantify the response of human operators to radar scope signals during World War II. This method provides a means of showing the relationship of POD and POFA as the acceptance criterion level varies. If a set of parts containing a single flaw (or a group of flaws of like sizes) is repetitively evaluated using an NDI process, a measure of performance capability for that flaw size or size range can be established (ie. the number of correct detections or POD and the number of false calls or POFA made as a result of the repetitive inspections). This level of operation can then be plotted as a single point on the ROC curve as shown in Figure 4-7. If we now change the acceptance criterion for the inspection process and repeat the inspection we can generate the data necessary to plot a second point on the ROC curve. By repeating this process a curve can be generated showing the relationship of POD and POFA as the inspection acceptance threshold changes.

The advantage of the ROC analysis is that of providing a quantitative description of the relationship of POD and POFA to aid in making inspection system management decisions. For example, if an increase in detection performance is required, the corresponding increase in the false call rate can be predicted and the corresponding impact on production can be planned for.

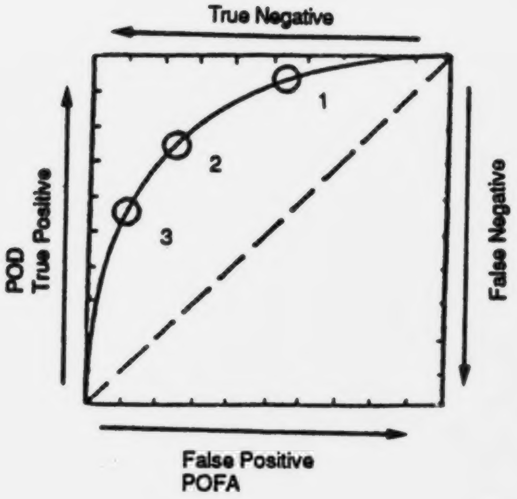


Figure 4-7
ROC Curve Showing Performance at Three Acceptance Criteria

A modified use of the ROC curve has been shown to provide a convenient and rapid method for comparing the relative proficiency of inspectors using a like NDI process (Ref. 4-10). A number of samples containing flaws of like size are evaluated by an operator using a specific inspection process along with an additional number of unflawed samples. The resulting performance generates a single point on the ROC curve as shown in Figure 4-8. The process is then repeated by several operators and variations in ability (skill, dexterity and decision making capabilities) are charted on the curve. The nearer the performance points fall to the upper left hand corner of the plot, the more discriminating the inspection results are. A zone of acceptable performance may be selected, and those operators whose performance falls outside that zone may be identified from the plot for retraining or reassignment.

4.4.2 Threshold Diagram Analysis

A second method for evaluating the discrimination capabilities of an inspection process is the threshold (specificity) diagram which presents POD and POFA as a function of the acceptance criteria as shown in Figure 4-9. The threshold diagram was developed by Rummel et al in 1986 to aid in the evaluation of data collected during the assessment of Air Force semi-automated eddy current inspection procedures (Ref. 4-6). The unique characteristic of this type of data presentation is the capability to readily visualize the effects of changing the acceptance criterion on POD and POFA. The threshold diagram is an effective NDE engineering tool to aid in establishing practical and economic acceptance criteria that will produce the required detection capabilities and at the same time provide a statistical estimate of the false call rate that can be expected.

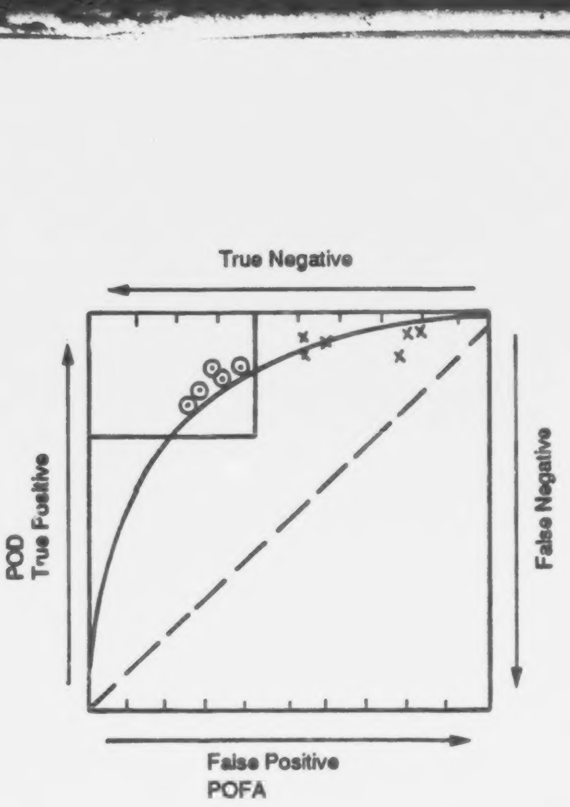


Figure 4-8
Modified ROC Analysis Showing Relative Operator Proficiency

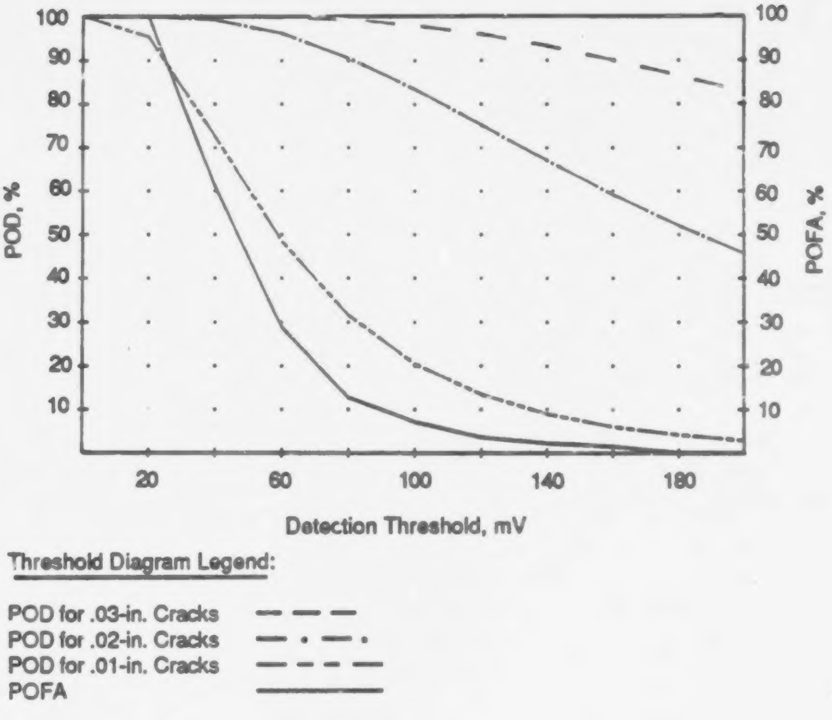


Figure 4-9 Typical Threshold Diagram for an NDI Procedure

4.5 DATA ANALYSIS APPLICATION

An array of the data analysis techniques discussed above was applied in analyzing the data generated during this program. For each inspection sequence completed, POD curves were plotted using the moving average and maximum likelihood techniques that have been described. The points for the moving average curves were plotted at the largest crack size in the overlapping 29 crack samples. This method was used to be consistent with the POD curves generated during previous NASA inspection reliability programs.

In addition to the moving average method, a POD curve was generated for each inspection sequence using the maximum likelihood method. This method has been adopted by the USAF as the accepted practice for analysis of Air Force NDI capability data. The POD curves generated using both methods are included in this report to provide a comparison of the results obtained using the two techniques.

A third POD curve was generated using the $\hat{a}$ versus a method for those inspection methods that provided quantitative signal amplitude. These POD curves are again included to allow a comparison of the analysis techniques. A threshold diagram was also generated for those inspection techniques that provided quantitative signal data to obtain a measure of discrimination capabilities. The methods used for analysis of the NDI reliability assessment data are detailed in Appendix A.

In addition to the POD curves, modified ROC analysis diagrams were used to aid in comparison of the ability of different inspection processes and personnel to discriminate between actual cracks and false indications. This method allows a quick comparison of performance capabilities using a single diagram.

Finally, for each inspection completed on a full test set, a point estimate and lower 95% confidence level estimate of detection probability was calculated for each of the following crack length ranges using the binomial distribution analysis:

0.010 - 0.050 in.,
0.051 - 0.100 in.,
0.101 - 0.150 in.,
0.151 - 0.250 in.

This combination of analysis techniques will allow comparison of the results presented in this report with the majority of NDI capability data that has been generated.

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5.0 RESULTS

A total 61 penetrant, 4 eddy current, and 3 ultrasonic inspection sequences were completed specifically for the NDI Reliability Assessment Program. In completing these 68 inspections, 6076 specimens were presented to 42 different inspectors for a total of 16,184 opportunities for crack detection.

In addition to the 68 inspections described above, the Inconel 718 and Haynes 188 test specimens were used with the concurrence of MSFC to conduct 17 additional penetrant inspection sequences for assessments requested by other government agencies. The data from these assessments have been included with the results from this program to augment the inspection capability data base. These 17 additional inspections accounted for the inspection of 1782 specimens using 11 different inspectors for a total of 4,810 opportunities for flaw detection. The results from all 85 inspection sequences that have been completed using the Inconel 718 and Haynes 188 specimens have been included within this report.

The penetrant inspections completed during the program were analyzed by penetrant material type and processing method as defined by Military Specification MIL-I-25135D, "Inspection Materials, Penetrants". MIL-I-25135D describes penetrant inspection systems as follows:

Penetrants

Type I - Fluorescent Penetrant
Type II - Visible Penetrant
Type III - Dual Mode (Reversible)

Sensitivity Levels

Sensitivity Level 1 - Low
Sensitivity Level 2 - Medium
Sensitivity Level 3 - High
Sensitivity Level 4 - Ultrahigh

Processing Methods

Method A - Water Washable
Method B - Post Emulsifiable (lipophilic)
Method C - Solvent Removable
Method D - Post Emulsifiable (hydrophilic)

Developers

Form a - Dry Powder Developer
Form b - Water Soluble Wet Developer
Form c - Water Suspendable Wet Developer
Form d - Nonaqueous Wet Developer

Broken down by the penetrant type and processing method, the penetrant inspections completed during this program were as follows:

46 water washable fluorescent penetrant inspections
(Type I, Method A),
17 post emulsifiable fluorescent penetrant inspections
(Type I, Method D),
5 solvent removable fluorescent penetrant inspections
(Type I, Method C),
6 red visible penetrant inspections (Type II, Methods A and C), and
4 reversible developer (dual mode) penetrant inspections
(Type III, Method A).

Processing techniques for the penetrant inspections included hand processing, processing on manual dip tank and spray penetrant lines and processing on automated spray processing lines.

The eddy current inspections consisted of 3 hand scan inspections and 1 computer controlled automatic scan inspection.

The ultrasonic inspections completed included two hand scan contact ultrasonic inspections and one computer controlled automatic scan immersion inspection.

The results from each of these inspection techniques and processes are presented in this chapter. POD curves plotted using both the moving average and maximum likelihood methods of analysis are presented for the best, worst and median individual performances for each inspection process. POD curves for all of the inspection sequences completed during this program are included in Appendix B. Modified ROC diagrams have been prepared for each process showing the POD and POFA performance for the 0.051-0.100 in. and 0.101-0.150 in. crack length ranges. For each inspection process described in this report, a table has been prepared that lists the total percentage of cracks contained in the test set that were detected and the percentage of false calls. The false call percentage was obtained by dividing the number of false calls recorded by the number of panel sides inspected (2 sides per panel). These tables also include the POD described by the point estimate and lower 95% confidence limit calculated using the binomial distribution for the following crack length ranges:

0.010 to 0.050 in.,
0.051 to 0.100 in.,
0.101 to 0.150 in.,
0.151 to 0.250 in.

There are a minimum of 60 cracks in each of these crack length ranges in both the Inconel 718 and Haynes 188 test sets. The actual numbers of cracks in these crack length ranges were used to calculate the point estimate and confidence limit values.

5.1 PENETRANT INSPECTION ASSESSMENT RESULTS

The materials and processing methods used for the 78 penetrant inspection sequences completed using the Inconel 718 and Haynes 188 test sets have been divided into 5 catagories by the type of penetrant material and process used as defined by MIL-I-25135D, "Inspection Materials, Penetrants". The assessments were started at each facility using the current facility practices and procedures. If it was apparent that the inspection procedures being used were not optimized from the observations of the assessment team or from the initial results, additional inspections were performed after implementing steps to gain additional detection capability.

5.1.1 Principles of Liquid Penetrant Inspection

Liquid penetrant inspection is one of the oldest, most widely applied, and technically simple of the commonly used NDI methods. Because of its apparent simplicity and wide application however, it is also one of the most abused methods in its application. A penetrant inspection is a multiple step process subject to the introduction of a number of variables with the performance of each step. The 5 basic steps required in the performance of a penetrant inspection regardless of the type of penetrant or process used and the inherent variations include:

Surface Preparation--All surfaces to be inspected must be thoroughly cleaned and dried prior to inspection. If the manufacturing process has resulted in mechanical action which may have smeared material over possible defect openings, the surface preparation must include an etch to remove the smeared material. Incomplete cleaning or etching will have a direct affect on the flaw detection capabilities of the penetrant inspection process.

Penetrant Application--Liquid penetrant is applied to form a thin film of penetrant on the clean hardware surface. This film should be left on the part surfaces long enough to allow maximum penetration of penetrant into defect openings. The penetrant dwell times used for manufacturing operations commonly range from 2 to 30 min. Variations to the penetrant process can be introduced during this step by the type, age, and cleanliness of the penetrant used; the thoroughness of its application; and the adequacy and consistency of the penetrant dwell times employed.

Removal of Excess Penetrant--Once sufficient time has elapsed for the penetrant to enter possible defects, the excess penetrant is removed from the hardware surfaces. The cleaning method used depends on the type of penetrant applied. Some penetrants can be simply removed by wiping or washing with water. Others require prior emulsification or the use of solvents to be removed. In completing this step, complete removal of the penetrant from the inspection surfaces is required without removing the pentrant that has entered the defects present. Variations to the process that occur during this step that effect flaw detection performance include emulsification time; emulsifier concentration, age and cleanliness; wash water temperature and pressure; wash times; and quantity of water or solvent applied.

Developer Application--A developing agent is applied to the hardware surfaces following removal of the penetrant to act as a blotter to assist the natural seepage of the penetrant back out of the defect openings and to spread it at the edges rendering the defects readily visible to the human eye. The developer can also act to provide a uniform background that provides a visual contrast between the defects and the remainder of the part. The type, age, and quantity of the developer used and the consistency of its application directly effect the flaw detection capabilities of the overall process.

Inspection--After allowing sufficient time for the defect indications to fully develop, the surface is inspected for indications of penetrant bleedback. Visible penetrant inspection is performed in white light and fluorescent penetrant inspection is performed in a suitably darkened area using long-wave ultraviolet light to illuminate the test piece. The performance of the inspection step of the process is effected by the time allowed for the flaw indications to develop; the intensity of the white light used for visible inspections and the blacklight used for fluorescent inspections; the background light conditions; the concentration and eye acuity of the inspector and his ability to discriminate actual defects from nonrelevant indications.

The overall capability of a penetrant inspection process is thus integrally dependent on the precise performance on each of these criticals steps. Precision in the performance of the individual steps is somewhat like the reliability factor for a component in a system; ie. the overall inspection capability can be no better than the performance of the weakest step and is correspondingly reduced by poor performance at any step in the process. The quantitative measurement of the detection capabilities of a penetrant inspection process therefore requires the isolation and quantification of the individual process steps and the corresponding effect on process yields.

5.1.2 Type I, Method A Penetrant Inspections

Three different fluorescent, water washable (Type I, Method A), sensitivity level penetrants were used during the assessment program. These included Sensitivity Level 2 and 3 penetrants as identified by QPL 25135-15, "Qualified Products List of Products Qualified Under MIL-I-25135", and a self-developing penetrant not included in QPL 25135-15.

The self-developing penetrant inspections were being performed on production hardware without the aid of developer according to specifications accepted by MSFC. During the assessments at the facilities using this material, additional inspections were performed using a nonaqueous wet developer (MIL-I-25135D Form d) to determine the additional detection capability that could be gained through the use of developer. The Sensitivity Level 2 and Level 3 penetrant inspections were performed with either dry powder developer (MIL-I-25135D Form a) or nonaqueous wet developer. The Type I, Method A penetrant inspections performed during the NDI reliability program are listed in Table 5-1.

Table 5-1
Method A (Water Washable) Penetrant Inspection Sequences

Inspection Number	Inspector Number	Test Set	Penetrant Sens. Level*	Developer	Process
1	1	Haynes 188	Self Devel.+	None	Hand
2	2	Haynes 188	Self Devel.	None	Hand
3	3	Haynes 188	Self Devel.	None	Hand
4	4	Inconel 718	Self Devel.	None	Hand
5	5	Inconel 718	Self Devel.	None	Hand
6	6	Inconel 718	Self Devel.	None	Hand
7	7	Haynes 188	Self Devel.	None	Hand
8	8	Haynes 188	Self Devel.	None	Hand
9	43	Inconel 718	Self Devel.	None	Hand
10	44	Haynes 188	Self Devel.	None	Hand
11	45	Inconel 718	Self Devel.	None	Hand
12	46	Haynes 188	Self Devel.	None	Hand
13	47	Inconel 718	Self Devel.	None	Hand
14	48	Haynes 188	Self Devel.	None	Hand
15	1	Haynes 188	Self Devel.	Nonaqueous	Hand
16	2	Haynes 188	Self Devel.	Nonaqueous	Hand
17	3	Haynes 188	Self Devel.	Nonaqueous	Hand
18	4	Inconel 718	Self Devel.	Nonaqueous	Hand
19	8	Haynes 188	Self Devel.	Nonaqueous	Hand
20	9	Inconel 718	Self Devel.	Nonaqueous	Hand
21	43	Inconel 718	Self Devel.	Nonaqueous	Hand
22	44	Haynes 138	Self Devel.	Nonaqueous	Hand
23	45	Inconel 718	Self Devel.	Nonaqueous	Hand
24	46	Haynes 188	Self Devel.	Nonaqueous	Hand
25	47	Inconel 718	Self Devel.	Nonaqueous	Hand
26	48	Haynes 188	Self Devel.	Nonaqueous	Hand
27	10	Inconel 718	2	Dry	Dip Tank
28	11	Inconel 718	2	Nonaqueous	Dip Tank
29	10	Inconel 718	2	Nonaqueous	Dip Tank
30	12	Haynes 188	3	Dry	Dip Tank
31	13	Inconel 718	3	Dry	Dip Tank
32	14	Inconel 718	3	Dry	Dip Tank
33	15	Haynes 188	3	Dry	Dip Tank
34	12	Haynes 188	3	Nonaqueous	Dip Tank
35	13	Inconel 718	3	Nonaqueous	Dip Tank
36	14	Inconel 718	3	Nonaqueous	Dip Tank
37	15	Haynes 188	3	Nonaqueous	Dip Tank
38	16	H188 Sbst A	3	Nonaqueous	Dip Tank
39	17	I718 Sbst A	3	Nonaqueous	Dip Tank
40	18	H188 Sbst B	3	Nonaqueous	Dip Tank
41	19	I718 Sbst B	3	Nonaqueous	Dip Tank
42	20	H188 Sbst A	3	Nonaqueous	Dip Tank
43	21	H188 Sbst A	3	Nonaqueous	Dip Tank
44	22	H188 Sbst B	3	Nonaqueous	Dip Tank
45	23	H188 Sbst B	3	Nonaqueous	Dip Tank
46	24	Inconel 718	3	Nonaqueous	Dip Tank

* Sensitivity Level per QPL 25135-15 (Qualified Products List for MIL-I-25135, Rev. D).

+ The self-developing penetrant used for Inspections #1-#26 is not listed by QPL 25135-15.

5.1.2.1 Self-Developing Penetrant Inspections (No Developer)--The inspection sequences performed with self-developing fluorescent, water washable penetrant are described in Table 5-1 as Inspections #1 through #26. These inspections were performed by applying the penetrant to the specimen surfaces by brush or foam tip applicator. All inspectors allowed the penetrant to dwell until the color shift that is characteristic of the self-developing penetrant took place (approximately 20 min. after application). The penetrant was removed from the panels by either a water spray or by hand wiping with damp rags. The specimens were allowed to air dry, wiped dry or were blown off with compressed air. Developer was not used for Inspections #1 through #14 per the procedures in use at the facilities assessed.

The background white light level in the inspection areas was higher than desired for all of the initial self-developing penetrant inspections with intensities ranging from 5 to 10 ft-candles. This level of white light limited the visibility of the fluorescent flaw indications and adversely effected performance. Military Standard MIL-STD-6866, "Inspection, Liquid Penetrant", requires a maximum white light level of 2 ft-candles for fluorescent penetrant inspection. The blacklight used for Inspection #7 had an ultraviolet light intensity of 400 $\mu W/cm^2$. which limited the brightness of crack indications during this inspection. All of the remaining inspections were performed with ultraviolet light intensities exceeding 1200 $\mu W/cm^2$.

POD curves were plotted for the self-developing penetrant inspections using the moving average and maximum likelihood methods of analysis. The POD curves showing the best, worst, and median individual performances for the self-developing penetrant inspections completed without developer are shown in Figures 5-1 through 5-3. POD curves for the remaining self-developing penetrant inspections performed without developer are included in Appendix B. The results from these inspections are also summarized in Table 5-2.

The maximum likelihood method POD curves show the curve fit to the experimental data (upper curve) and the calculated lower 95% confidence curve (lower curve). At 100% POD and 0% POD, "x's" have been plotted at the corresponding flaw length for each crack that was detected (100%) or not detected (0%).

The moving average POD curves show the point estimate values calculated from the moving 29 crack samples plotted as "x's" and a line fit to these points using a log logistic transformation and liner regression technique. The lower 95% confidence values calculated for each point estimate using the binomial method have been plotted as boxes.

The average percentage of flaws detected using the self-developing penetrant without developer process was 49.8% and individual inspection performances ranged from 17.6% to 78.5% of the flaws detected. Only one inspection (Inspection #11) demonstrated a flaw detection capability that approached 90% POD at the lower 95% confidence level for the longest flaw length range (0.151-0.250 in.). Individual inspection performances for the 0.051 to 0.100 in. and 0.101 to 0.150 in. flaw length ranges are shown by the modified ROC diagrams shown in Figures 5-4 and 5-5.

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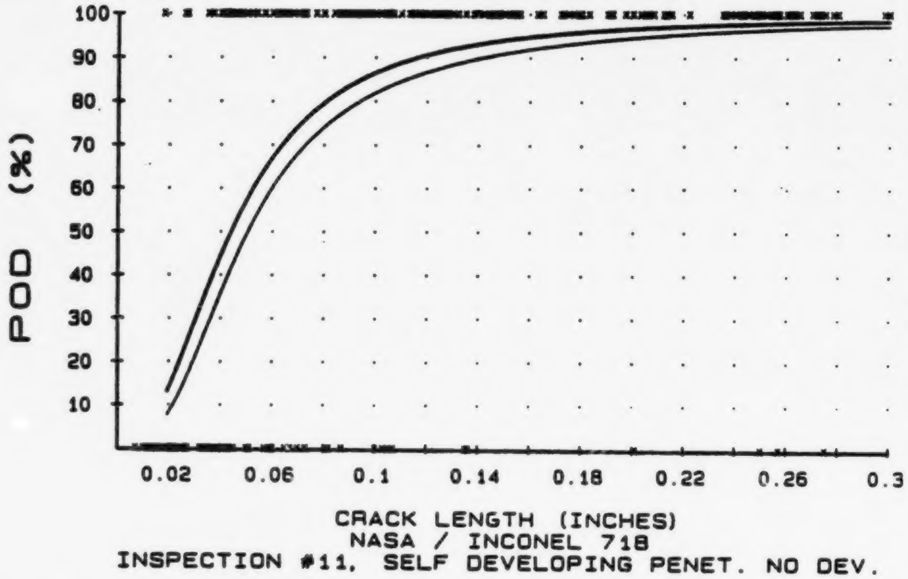
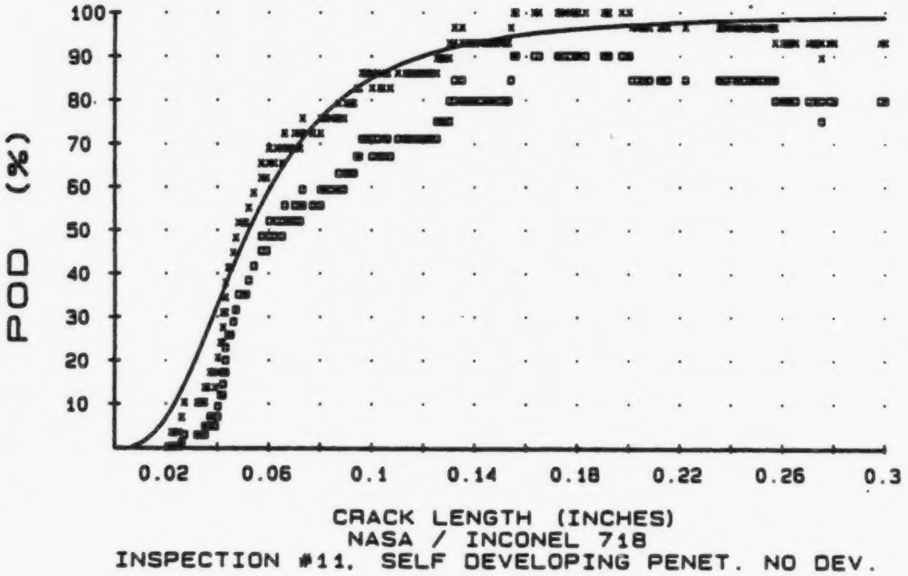


Inspection #11
Inconel 718
110 Specimens
281 Cracks
75.4% Detected
9 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-1
POD Curves for Best Individual Performance for Inspection Performed with Self-Developing Penetrant and No Developer

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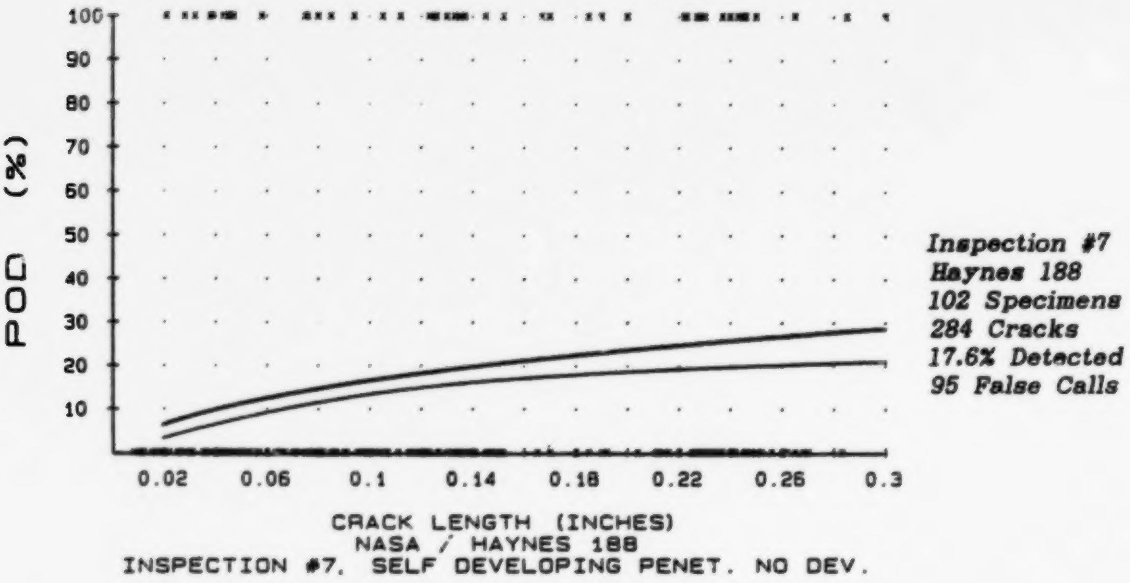
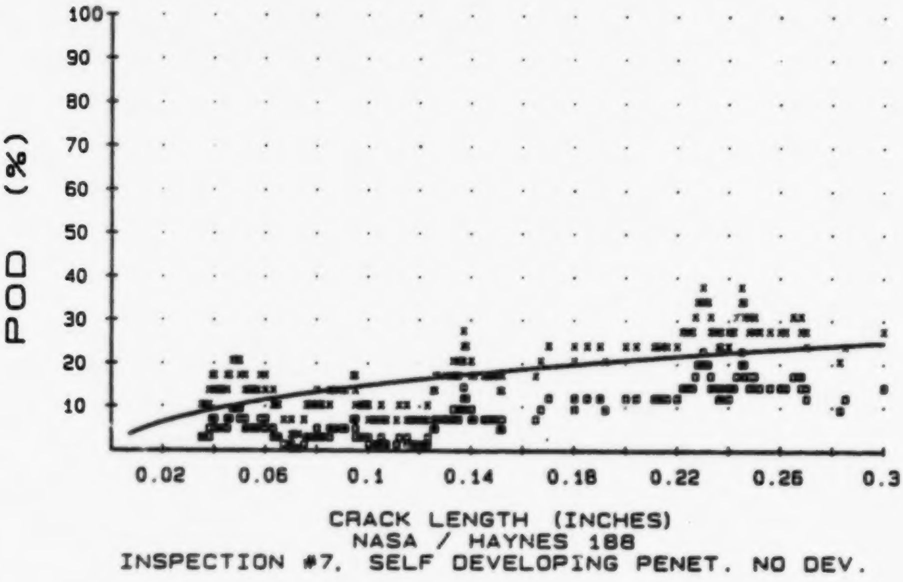


Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-2
POD Curves for Worst Individual Performance for Inspection Performed with Self-Developing Penetrant and No Developer

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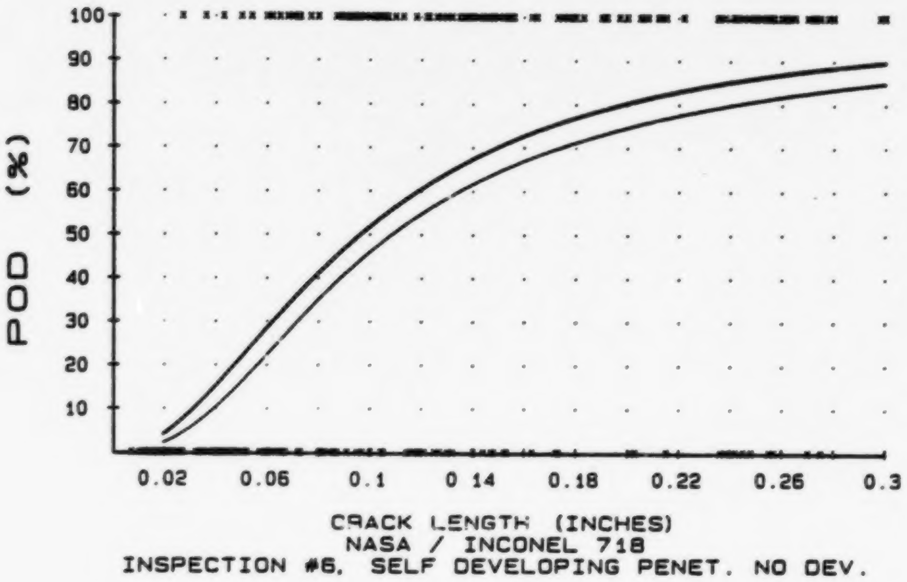
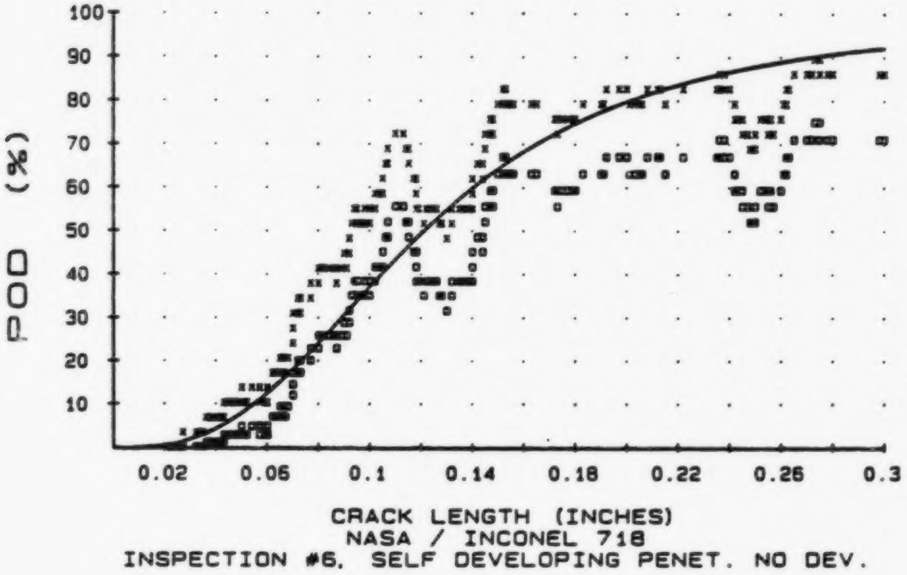


Inspection #6
Inconel 718
110 Specimens
281 Cracks
52.3% Detected
24 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-3
POD Curves for Median Individual Performance for Inspection Performed with Self-Developing Penetrant and No Developer

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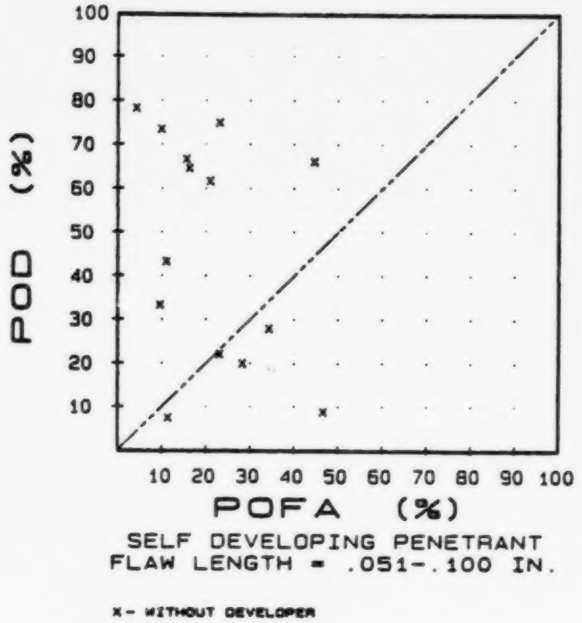

Figure 5-4
Modified ROC Analysis for Inspections Performed with Self-Developing Penetrant and No Developer (0.051-0.100 in. Flaw Length Range)

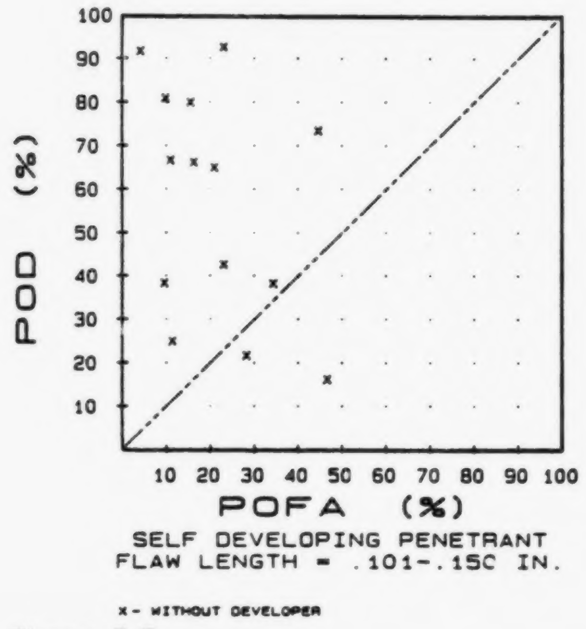

Figure 5-5
Modified ROC Analysis for Inspections Performed with Self-Developing Penetrant and No Developer (0.101-0.150 in. Flaw Length Range)

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Table 5-2
Summary of Self-Developing Penetrant Inspection Results
Inspections Performed Without Developer

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
1	78.5	23.0	53.8%(42.9%)	75.0%(64.9%)	92.6%(85.5%)	93.3%(85.4%)
2	29.9	34.3	16.9%(9.8%)	27.9%(19.1%)	38.2%(28.4%)	36.7%(26.3%)
3	32.4	23.0	12.3%(6.3%)	22.1%(14.1%)	42.6%(32.5%)	51.7%(40.4%)
4	37.4	9.5	4.8%(1.3%)	33.3%(23.3%)	38.3%(27.8%)	61.7%(50.2%)
5	25.6	28.2	3.2%(0.6%)	20.0%(12.0%)	21.7%(13.3%)	41.7%(30.9%)
6	52.3	10.9	6.3%(2.2%)	43.3%(32.6%)	66.7%(55.4%)	76.7%(65.9%)
7	17.6	46.6	13.8%(7.4%)	8.8%(3.9%)	16.2%(9.3%)	31.7%(21.9%)
8	20.1	11.3	3.8%(0.6%)	7.4%(2.9%)	25.0%(16.5%)	38.3%(27.8%)
9	66.2	15.5	28.5%(19.4%)	66.7%(55.4%)	80.0%(69.6%)	88.3%(79.2%)
10	69.7	44.6	50.8%(40.0%)	66.2%(55.6%)	73.5%(63.3%)	83.3%(73.4%)
11	75.4	4.1	28.6%(19.4%)	78.3%(67.9%)	91.7%(83.3%)	96.7%(89.9%)
12	73.9	9.8	46.2%(35.5%)	73.5%(63.3%)	80.9%(71.3%)	93.3%(85.4%)
13	58.7	20.9	19.0%(11.4%)	61.7%(50.2%)	65.0%(53.6%)	83.3%(73.4%)
14	58.8	16.2	16.9%(9.8%)	64.7%(54.1%)	66.2%(55.6%)	83.3%(73.4%)
Ave.	49.8	21.3	21.7%(14.7%)	46.4%(37.1%)	57.0%(47.5%)	68.6%(58.8%)

The modified ROC diagrams clearly show that the self-developing penetrant process produced widely varying results in both the percentage of flaws detected and the number of false calls. The low visibility of the flaw indications provided by the self-developing penetrant makes the process very dependent on the ability of the inspectors to detect low intensity indications on a reflective metal background.

5.1.2.2 Self-Developing Penetrant Inspections (with Developer)-- It was observed during the inspections performed without developer that the crack indications were weak with little distinction in brightness between actual defects and those indications caused by machine marks, scratches, gouges, etc. As a result, additional inspections were performed with the nonaqueous wet developer materials available at the facilities to determine the effect of developer on detection capability and the number of false calls. Inspections #15 through #26 listed in Table 5-1 are the self-developing penetrant inspections performed with nonaqueous wet developer. The POD curves showing the best, worst, and median individual performances for inspections performed using the self-developing penetrant with developer are shown in Figures 5-6 through 5-8. POD curves for all of the self-developing penetrant inspections performed with developer are included in Appendix B. Modified ROC diagrams for the inspections performed with developer are shown in Figures 5-9 and 5-10.

The results from the inspection sequences completed using the self-developing penetrant with developer have been summarized in Table 5-3.

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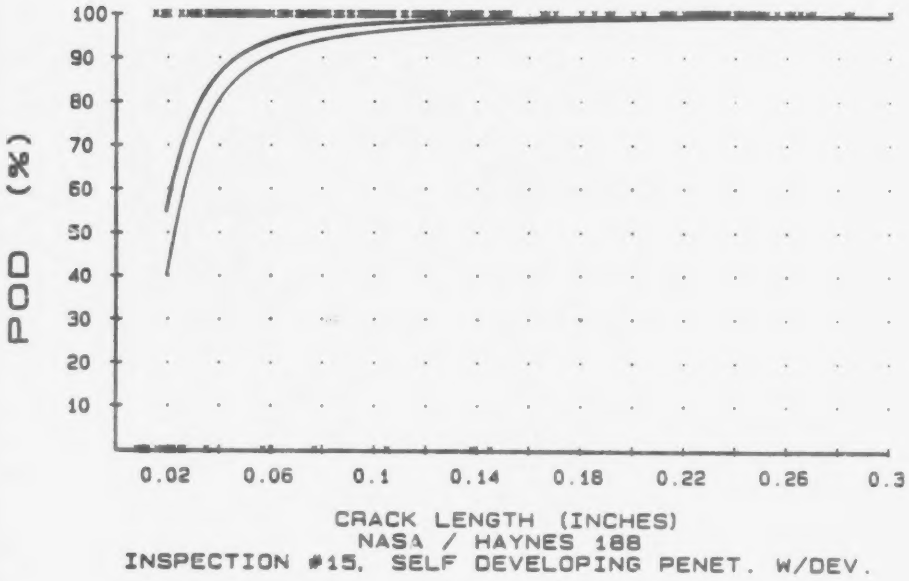
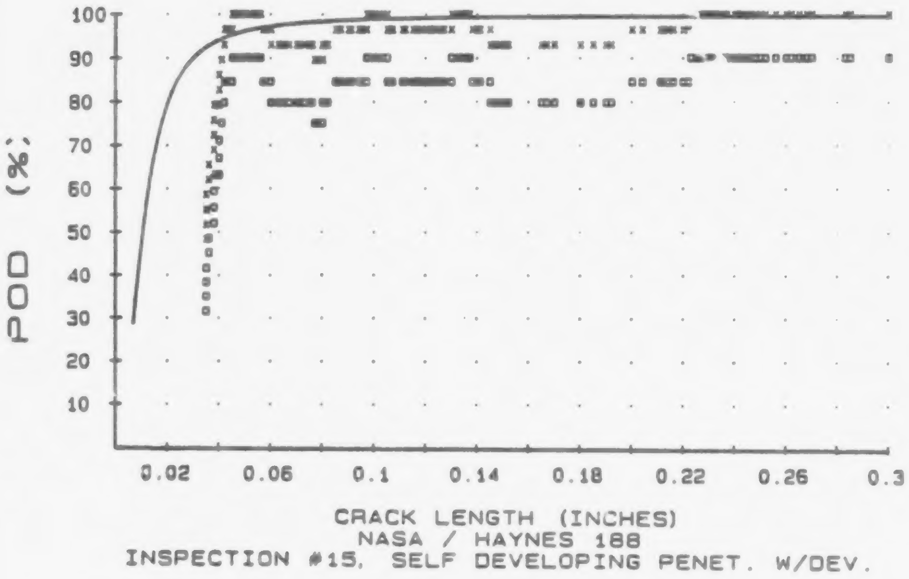


Inspection #15
Haynes 188
102 Specimens
284 Cracks
92.2% Detected
3 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-6
POD Curves for Best Individual Performance for Inspection Performed with Self-Developing Penetrant and Nonaqueous Developer

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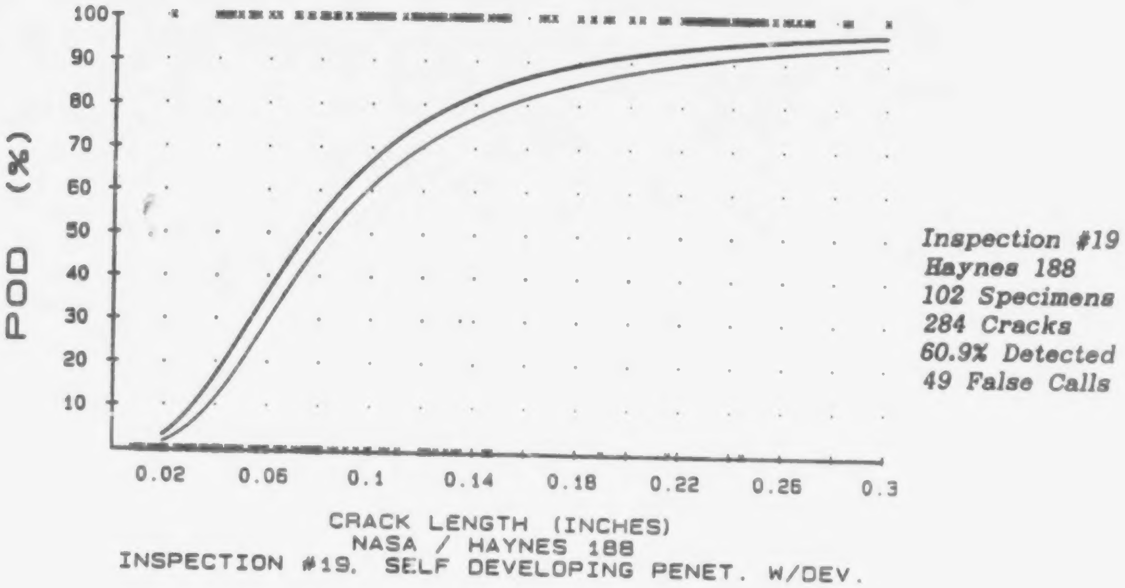
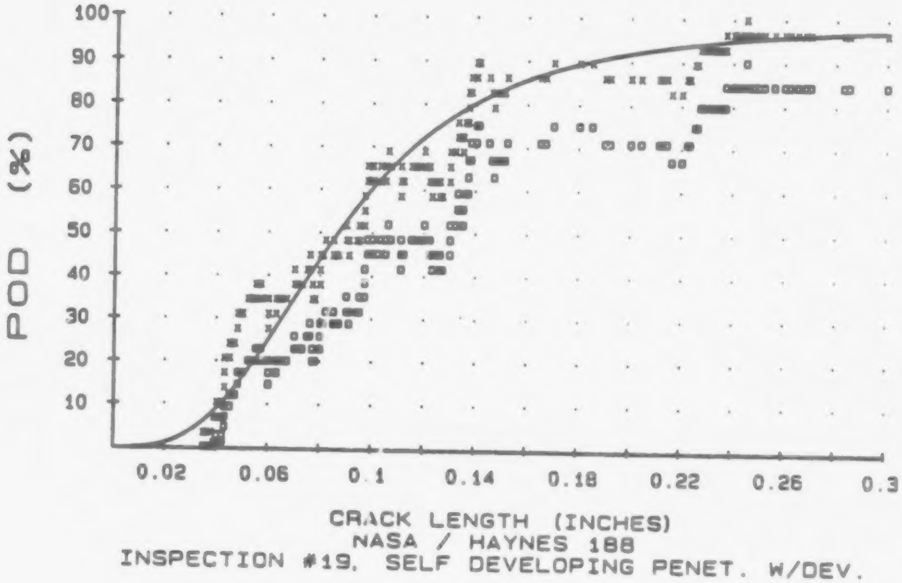


Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-7
POD Curves for Worst Individual Performance for Inspection Performed with Self-Developing Penetrant and Nonaqueous Developer

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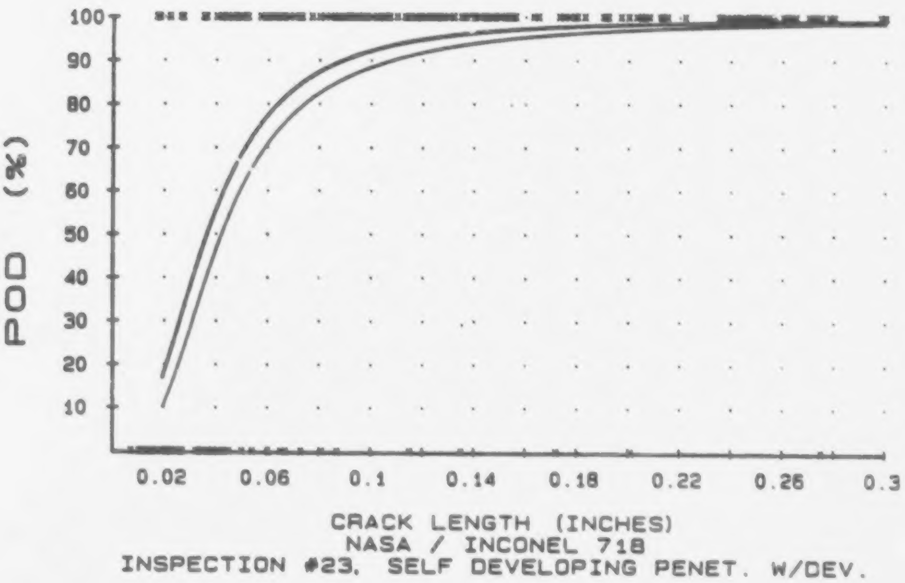
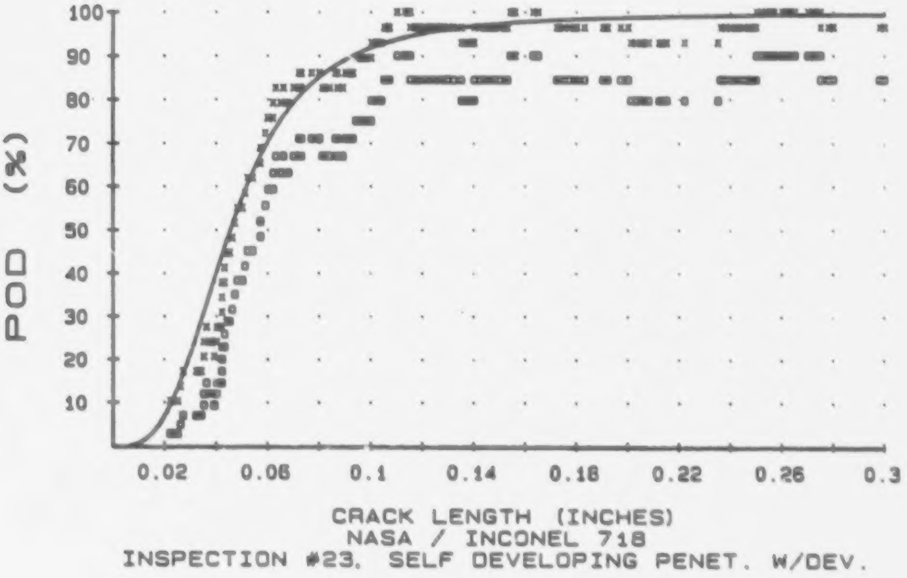


Inspection #23
Inconel 718
110 Specimens
281 Cracks
80.1% Detected
3 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-8
POD Curves for Median Individual Performance for Inspection Performed with Self-Developing Penetrant and Nonaqueous Developer

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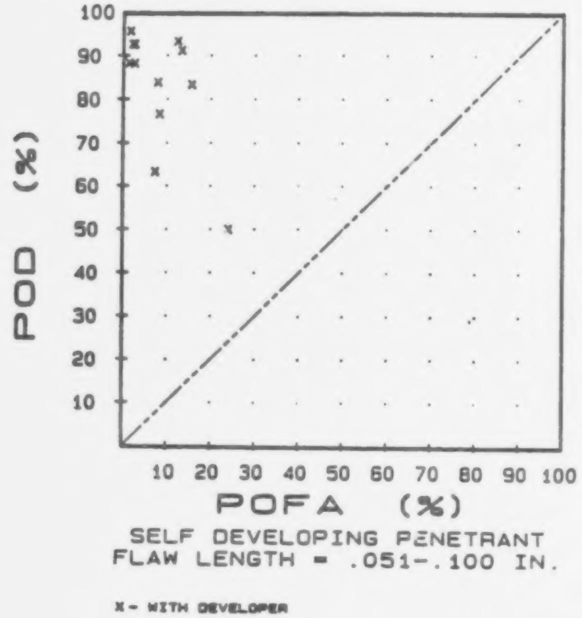

Figure 5-9
Modified ROC Analysis for Inspections Performed with Self-Developing Penetrant and Nonaqueous Developer (0.051-0.100 in. Flaw Length Range)

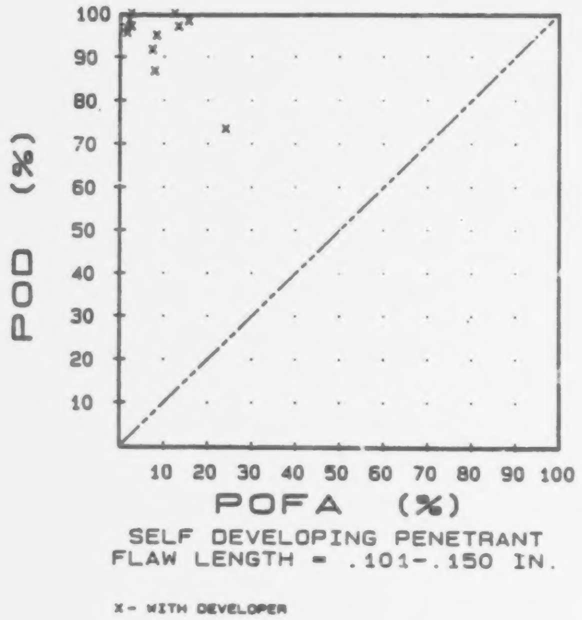

Figure 5-10
Modified ROC Analysis for Inspections Performed with Self-Developing Penetrant and Nonaqueous Developer (0.101-0.150 in. Flaw Length Range)

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Table 5-3
Summary of Self-Developing Penetrant Inspection Results
Inspections Performed with Developer

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
15	92.2	1.5	78.5%(68.4%)	95.6%(89.0%)	95.6%(89.0%)	100.0%(95.1%)
16	87.3	2.5	56.9%(46.0%)	92.6%(85.5%)	100.0%(95.7%)	98.3%(92.4%)
17	77.1	7.8	38.5%(28.3%)	83.8%(74.7%)	86.8%(78.0%)	95.0%(87.6%)
18	65.4	7.3	7.9%(3.2%)	63.3%(51.9%)	91.7%(83.3%)	90.0%(81.2%)
19	60.9	24.0	15.4%(8.2%)	50.0%(39.3%)	73.5%(63.3%)	95.0%(87.6%)
20	74.7	8.2	20.6%(12.7%)	76.7%(65.9%)	95.0%(87.6%)	96.7%(89.9%)
21	80.4	15.5	31.7%(22.1%)	83.3%(73.4%)	98.3%(92.4%)	96.7%(89.9%)
22	88.3	13.2	66.2%(55.3%)	91.2%(83.3%)	97.1%(91.0%)	98.3%(92.4%)
23	80.1	1.3	33.3%(23.5%)	88.3%(79.2%)	96.7%(89.9%)	96.7%(89.9%)
24	87.7	2.5	66.2%(55.3%)	88.2%(79.8%)	97.1%(91.0%)	96.7%(89.9%)
25	84.7	12.3	41.3%(30.8%)	93.3%(85.4%)	100.0%(95.1%)	100.0%(95.1%)
26	85.2	2.0	49.2%(38.5%)	92.6%(85.5%)	98.5%(93.2%)	98.3%(92.4%)
Ave.	80.3	8.2	42.1%(32.7%)	83.2%(74.4%)	94.2%(87.5%)	96.8%(90.3%)

The use of developer with the self-developing penetrant provided a significant improvement in flaw detection capability. Average detection increased from 49.8% of the flaws detected for the inspections performed without developer to 80.3% detection for the inspections performed with developer. The use of developer also decreased the false calls from an average of 21.3% to 8.2%. Only 3 of the 14 inspections performed without developer were able to detect the largest flaw length range (0.151-0.250 in.) with 90% POD (point estimate) or better. With the use of developer, the average detection for both the 0.101-0.150 in. and the 0.151-0.250 in. flaw length ranges exceeded 90% POD. The modfied ROC diagrams for the inspections performed with developer show a considerable decrease in the variation of performance levels demonstrated by the different inspectors indicating that the use of developer makes the process much less dependent on the skill of the individual operators.

5.1.2.3 Type I, Method A, Sensitivity Level 2 Penetrant Inspections-- Three Type I, Method A (fluorescent, water washable) penetrant inspections were performed using a Sensitivity Level 2 penetrant. These inspection sequences are listed in Table 5-1 as Inspections #27 through #29. Penetrant was applied to the test specimens by submersion in a dip tank. The inspectors allowed the penetrant to dwell on the specimen surfaces for 30 to 45 min. before washing. The water wash was carried out in a darkened booth under blacklight. An open ended hose with a high pressure stream of water was used for washing during Inspections #27 and #28 which resulted in over removal of penetrant and weakened crack indications. A spray nozzle was installed prior to the performance of Inspection #29.

Following the wash procedure, the specimens were dried in an air circulating oven. The oven temperature during Inspections #27 and #28 exceeded 200 deg F which may have resulted in heat fade of the fluorescence and increased viscosity of the penetrant in the cracks due to evaporation. The manufacturer of the particular penetrant used recommends that oven temperatures not exceed 140 deg F for this material and that parts be removed from the oven immediately after all moisture has evaporated from the part surfaces. The oven temperature was reduced to 150 deg F prior to Inspection #29 and the specimens were closely monitored to prevent over drying.

Dry powder developer (Form a) was being used for production applications with the Sensitivity Level 2 penetrant at the facility being assessed. Inspection #27 was performed using the dry developer per facility procedures. The developer was applied by hand dusting a cotton ball applicator over the specimen surfaces. This method resulted in uneven application and inconsistent indication brightness. Inspections #28 and #29 were performed using a nonaqueous wet developer (MIL-I-25135D Form d) to determine if a nonaqueous developer would result in more consistent indications and improved detection capabilities.

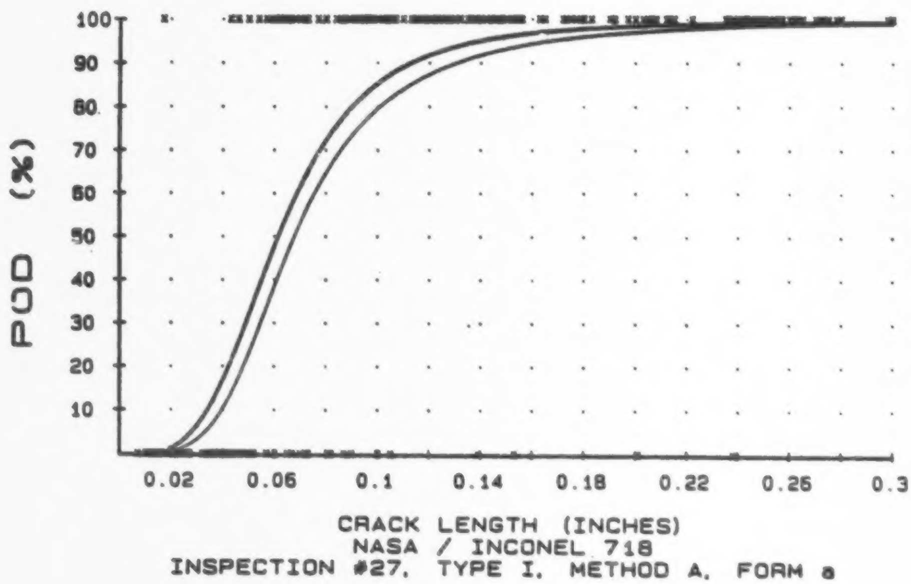
The POD curves for the Type I, Method A, Sensitivity Level 2 penetrant inspections are shown in Figures 5-11 through 5-13. Modified ROC diagrams for the 0.051 to 0.100 in. and 0.101 to 0.150 in. flaw length ranges are shown in Figures 5-14 and 5-15. The results of the inspections are summarized in Table 5-4.

Table 5-4
Summary of Type I, Method A, Sensitivity Level 2 Penetrant Inspection Results

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
27	69.0	3.6	6.3%(2.2%)	68.3%(57.1%)	96.7%(89.9%)	95.0%(87.6%)
28	75.1	4.5	19.0%(11.4%)	76.7%(65.9%)	98.3%(92.4%)	96.7%(89.9%)
29	78.6	2.7	22.2%(13.9%)	90.0%(81.2%)	100.0%(95.1%)	93.3%(85.4%)
Ave.	74.2	3.6	15.8%(9.2%)	78.3%(68.1%)	98.3%(92.5%)	95.0%(87.6%)

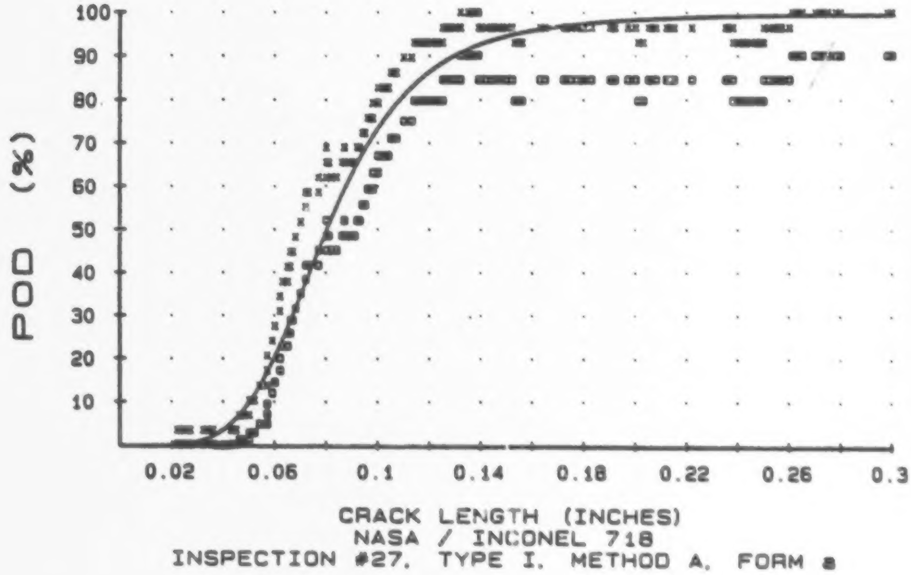
Overall flaw detection for the Sensitivity Level 2 inspections improved from 69.0% (Inspection #27) detection to 75.1% detection (Inspection #28) by replacing the dry powder developer with nonaqueous wet developer. Detection increased further to 78.6% during Inspection #29 by reducing the oven temperature and using a spray nozzle rather than a high pressure stream of water for washing. Examination of Table 5-4 and the modified ROC diagrams indicates that the increase in detection resulting from the developer change and process optimization occurred in the less than 0.100 in. flaw length ranges. Very little change in detection capability resulted for flaws over 0.100 in.

The false call percentage for all three Sensitivity Level 2 inspections was low ranging from 2.7% to 3.6%.



Inspection #27
Inconel 718
110 Specimens
281 Cracks
69.0% Detected
8 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-11
POD Curves for Inspection #27 Performed with Type I, Method A, Sensitivity Level 2 Penetrant

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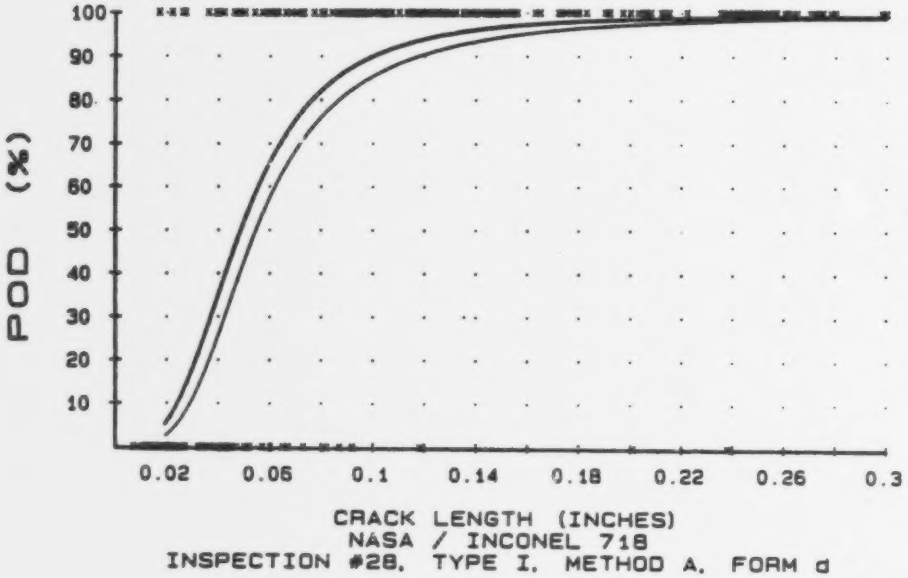
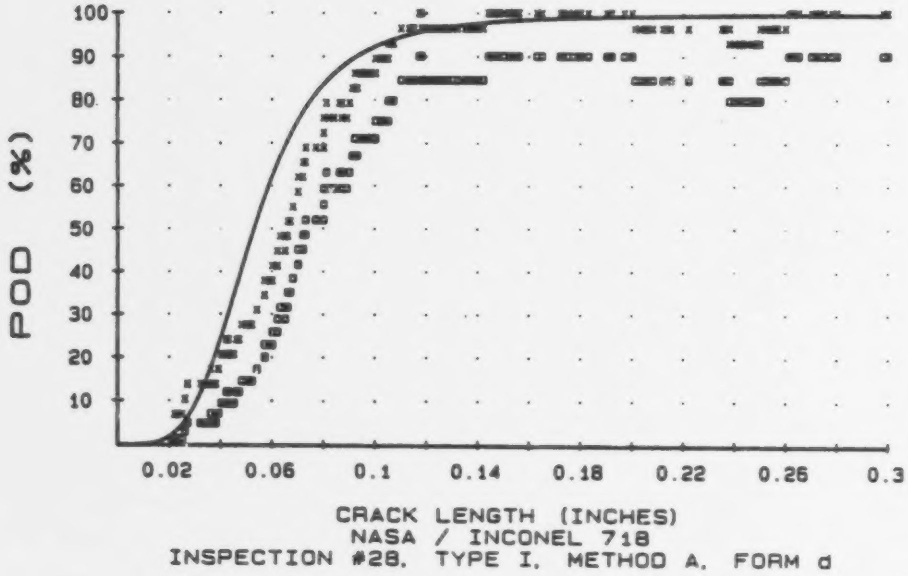


Inspection #28
Inconel 718
110 Specimens
281 Cracks
75.1% Detected
10 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-12
POD Curves for Inspection #28 Performed with Type I, Method A, Sensitivity Level 2 Penetrant

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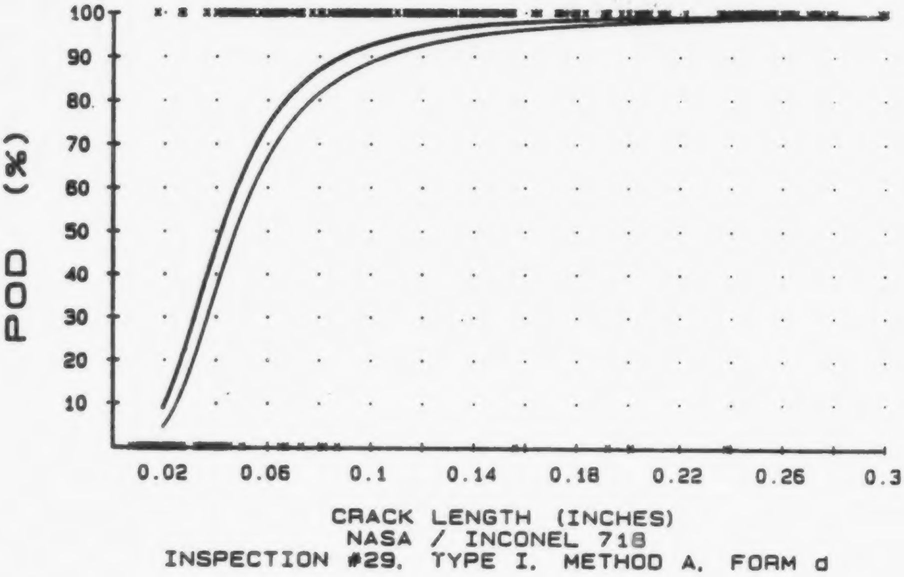
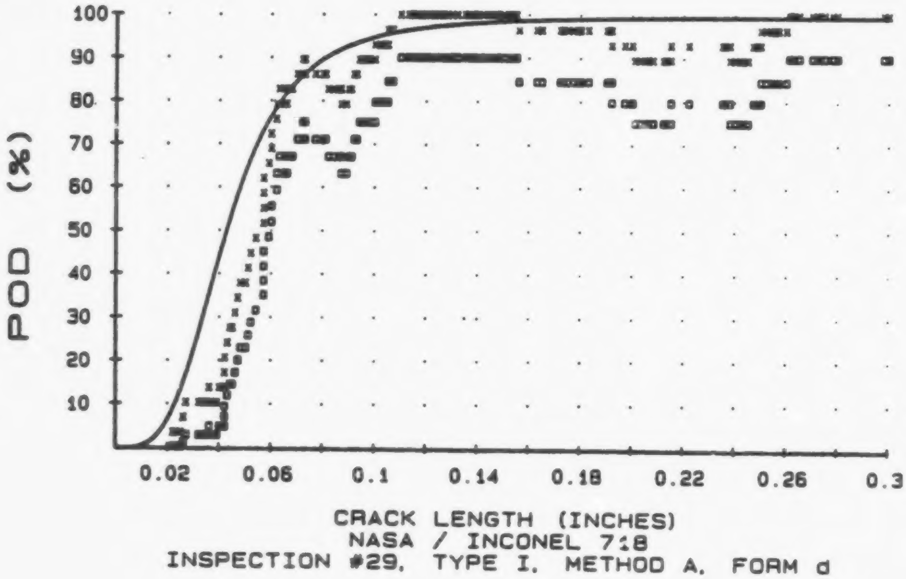


Inspection #29
Inconel 718
110 Specimens
281 Cracks
78.6% Detected
6 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-13
POD Curves for Inspection #29 Performed with Type I, Method A, Sensitivity Level 2 Penetrant

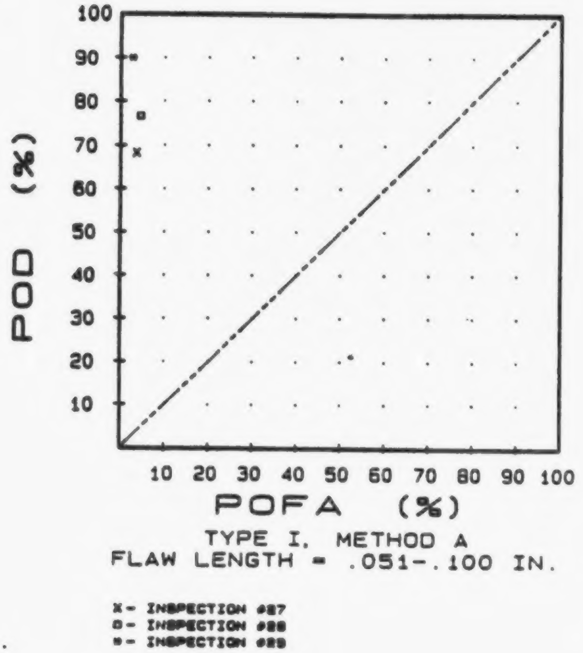


Figure 5-14
Modified ROC Analysis for Inspections Performed with Type I, Method A, Sensitivity Level 2 Penetrant (0.051-0.100 in. Flaw Length Range)

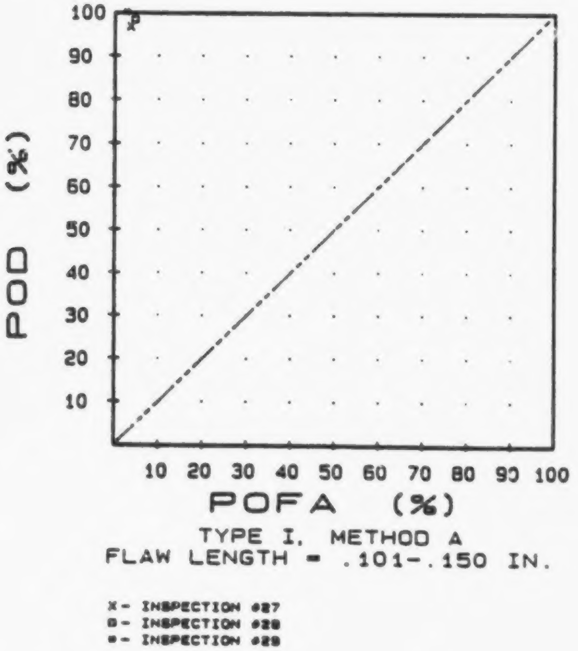


Figure 5-15
Modified ROC Analysis for Inspections Performed with Type I, Method A, Sensitivity Level 2 Penetrant (0.101-0.150 in. Flaw Lengh Range)

5.1.2.4 Type I, Method A, Sensitivity Level 3 Penetrant Inspections-- Seventeen Sensitivity Level 3 water washable penetrant inspections were completed. These inspections are listed in Table 5-1 as Inspections #30 through #46. Nine of these inspections were performed on the full Inconel 718 or Haynes 188 test sets. For the remainder of the inspections, subsets of the full test sets were used. The specimens making up the subsets were selected to provide a concentration of flaw lengths around the anticipated detection capabilities of the inspection processes. The number of panels making up the subsets ranged from 18 to 24 with 68 to 90 flaws in each specimen subset. Use of the subsets allowed for a more extensive examination of process variables in the time available for data collection.

Processing for the Sensitivity Level 3 penetrant inspections was performed by lowering full specimen racks (8 specimens) into penetrant dip tanks until the specimens were submerged. The specimens were then raised and the penetrant allowed to drain/dwell for times ranging from 5 to 45 min. The excess penetrant was washed from the part surfaces under blacklights using a course water spray at 35-40 psi and a water temperature of 75-80 deg F. The majority of inspectors removed the specimens from the racks and washed them individually, placing them in a clean rack as they finished each panel. Some inspectors cleaned the specimens while leaving them in the racks. Both methods worked satisfactorily, however it was common for the blacklight intensity in the wash booths to be low enough that it was difficult to determine when all the excess penetrant had been removed without examining the panels individually. The cleaned specimens were allowed to dry in circulating air ovens at temperatures ranging from 130 to 150 deg F until dry (approximately 10 min.).

The Sensitivity Level 3 water washable penetrant inspections were performed using either dry powder developer (Form a) or nonaqueous wet developer (Form d). The dry powder developer was used for Inspections #30 - #33 and was applied by covering the specimens with the powder and then shaking or lightly blowing the excess powder off the specimen surfaces. Before inspecting the specimens, the operators allowed the flaw indications to develop or bleed-out for times ranging from 0 to 10 min.

Nonaqueous wet developer was used for Inspections #34-#46 and was applied by aerosol can or by an air brush. As with the dry developer, the inspectors allowed the flaw indications to develop for times ranging from 0 to 10 min. before beginning their inspection of the specimens.

The results from the Sensitivity Level 3 water washable penetrant inspections are summarized in Table 5-5. Inspections #38-#45 were performed using subsets of the Inconel 718 and Haynes 188 test specimen sets. Because of the reduced sample sizes for these inspections, the lower 95% confidence limit detection capabilities cannot be calculated and provide a meaningful comparison with the full test set confidence limit results. For this reason, lower confidence bounds have not been included in Table 5-5 for the subset inspections.

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Table 5-5
Summary of Type I, Method A, Sensitivity Level 3 Penetrant Inspection Results

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
30	82.7	12.7	66.2%(55.3%)	80.9%(71.3%)	85.3%(76.3%)	98.3%(92.4%)
31	87.2	0.9	52.4%(41.3%)	93.3%(85.4%)	100.0%(95.1%)	100.0%(95.1%)
32	81.1	1.4	36.5%(26.4%)	88.3%(79.2%)	98.3%(92.4%)	95.0%(87.6%)
33	91.5	0.0	72.3%(61.7%)	95.6%(89.0%)	98.5%(93.2%)	100.0%(95.1%)
34	88.0	20.1	69.2%(58.5%)	89.7%(81.5%)	92.6%(85.6%)	100.0%(95.1%)
35	87.9	0.9	54.0%(42.9%)	95.0%(87.6%)	100.0%(95.1%)	100.0%(95.1%)
36	83.6	2.7	41.3%(30.8%)	91.7%(83.3%)	100.0%(95.1%)	96.7%(89.9%)
37	94.0	2.0	78.5%(68.4%)	97.1%(91.0%)	100.0%(95.7%)	100.0%(95.1%)
38	87.5	13.0	82.4%(-----)	87.5%(-----)	78.6%(-----)	100.0%(-----)
39	92.2	12.5	70.0%(-----)	95.5%(-----)	100.0%(-----)	100.0%(-----)
40	89.7	9.5	68.8%(-----)	90.0%(-----)	100.0%(-----)	100.0%(-----)
41	93.3	6.2	73.7%(-----)	100.0%(-----)	100.0%(-----)	100.0%(-----)
42	81.9	4.3	64.7%(-----)	83.3%(-----)	85.7%(-----)	100.0%(-----)
43	91.7	21.7	82.4%(-----)	91.7%(-----)	92.9%(-----)	100.0%(-----)
44	88.2	14.2	68.8%(-----)	90.0%(-----)	94.4%(-----)	100.0%(-----)
45	91.2	33.0	75.0%(-----)	90.0%(-----)	100.0%(-----)	100.0%(-----)
46	81.5	0.5	34.9%(25.0%)	90.0%(81.2%)	98.3%(92.4%)	96.7%(89.9%)
Ave.	87.8	9.2	64.2%(45.5%)	91.2%(83.3%)	95.6%(91.2%)	99.2%(92.8%)

POD curves for inspections performed using the full test sets were generated by the moving average and maximum likelihood analysis methods. The test specimen subset inspections provided insufficient data for effective use of the moving average technique. Consequently, the subset inspection POD curves were plotted using the maximum likelihood method exclusively. The maximum likelihood method calculates POD based on the individual crack finds and misses and does not require grouping of the data. As a result, this method is less dependent on the quantity of data available.

The POD curves for the four inspection sequences performed using dry powder developer are shown in Figures 5-16 through 5-19. The POD curves for the best, worst and median individual performances using nonaqueous wet developer on the full test sets are shown in Figures 5-20 through 5-22. POD curves for all of the Sensitivity Level 3 inspections are included in Appendix B.

The Sensitivity Level 3 individual inspection performance for flaws in the 0.051-0.100 in. and 0.101-0.150 in. flaw length ranges were plotted using the modified ROC analysis and are shown in Figures 5-23 and 5-24. The four inspections performed with the dry powder developer have been distinquished from the remaining inspections performed with the nonaqueous wet developer. A significant number of the Sensitivity Level 3 inspections had performance levels exceeding 90% detection with less than 10% false calls (indicated by the box in the upper left corner of the diagram) for both flaw length ranges.

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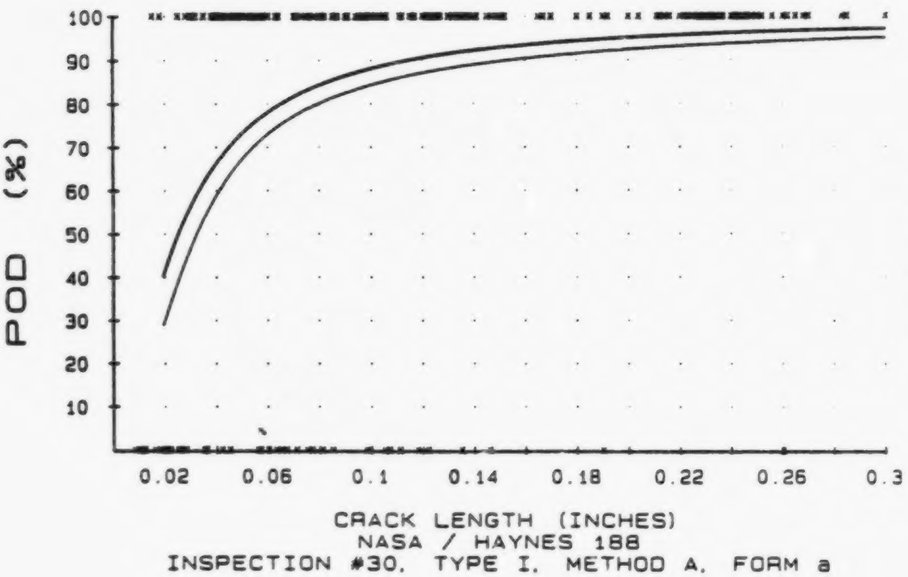
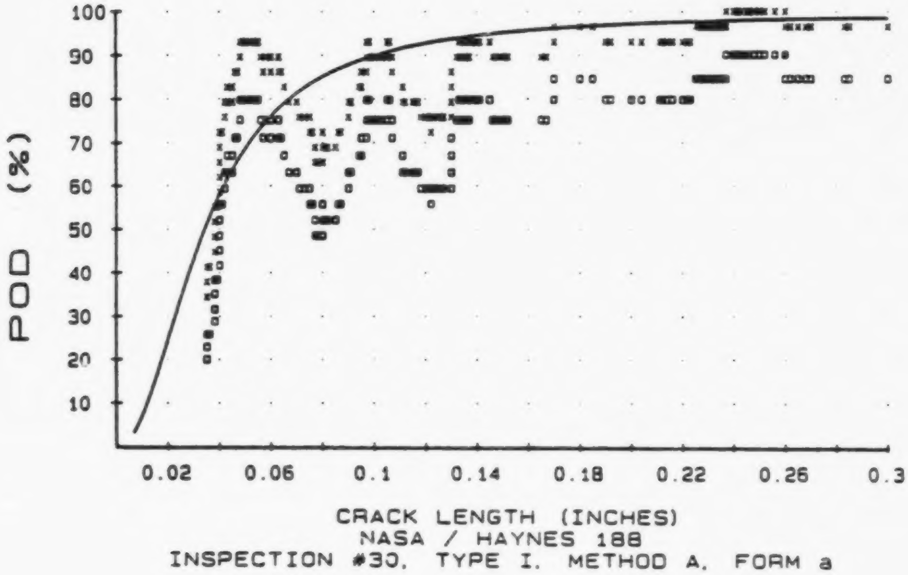


Inspection #30
Haynes 188
102 Specimens
284 Cracks
82.7% Detected
26 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-16
POD Curves for Inspection #30 Performed with Type I, Method A, Sensitivity Level 3 Penetrant and Dry Develper

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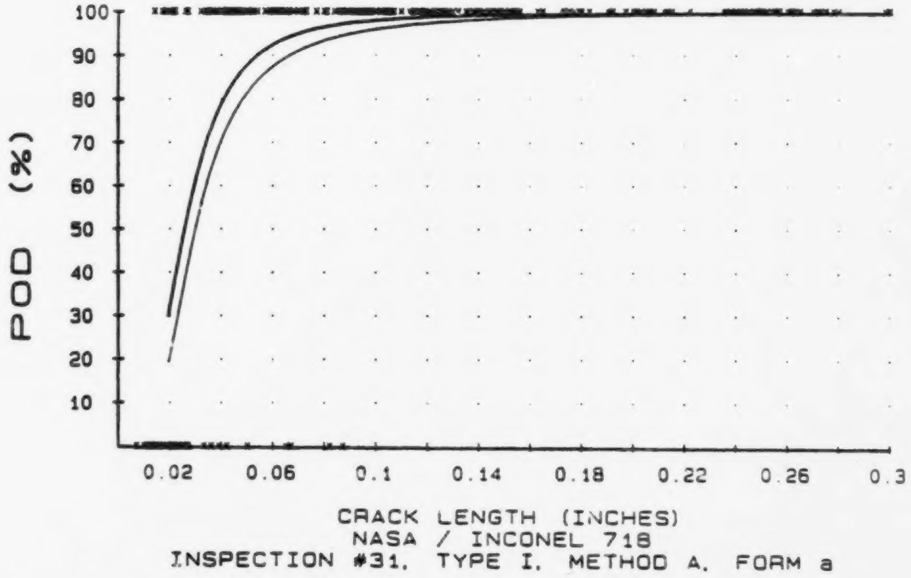
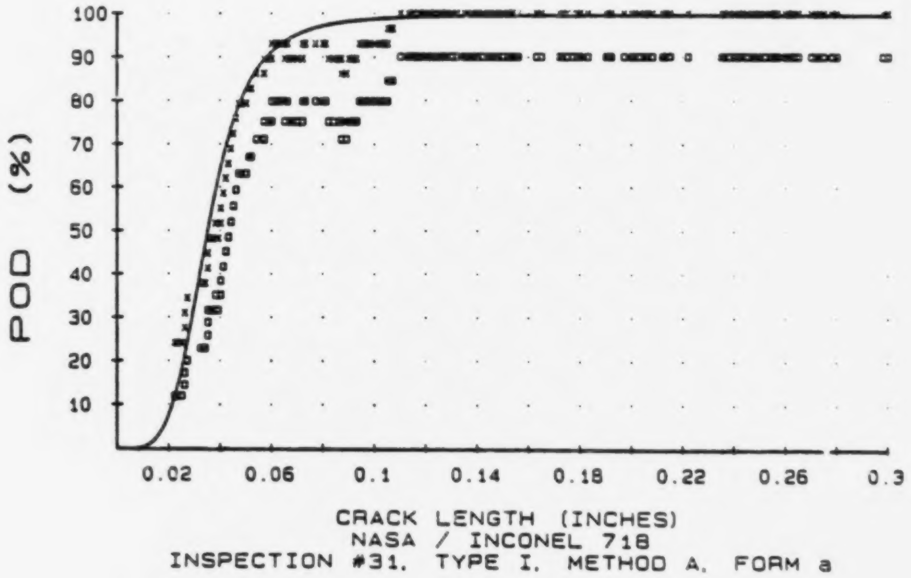


Inspection #31
Inconel 718
110 Specimens
281 Cracks
87.2% Detected
2 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-17
POD Curves for Inspection #31 Performed with Type I, Method A, Sensitivity Level 3 Penetrant and Dry Developer

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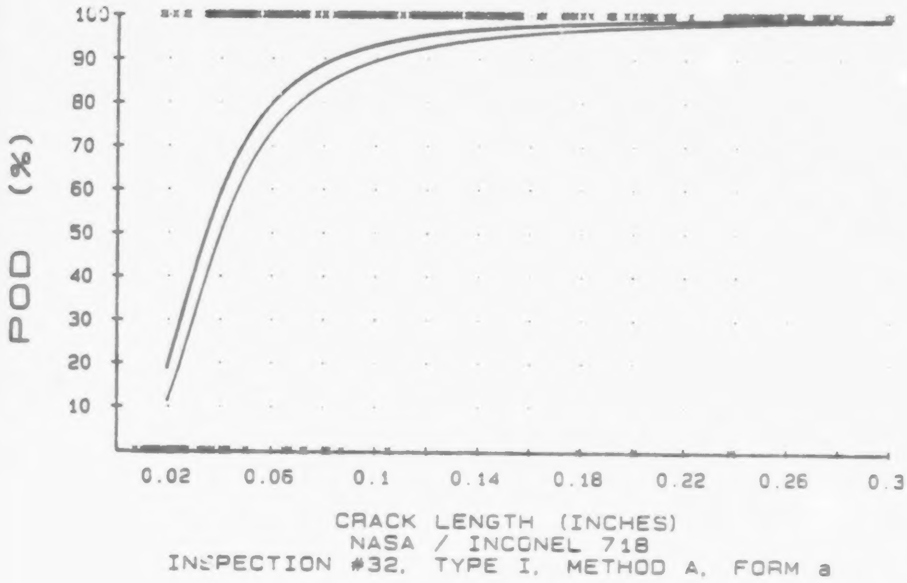
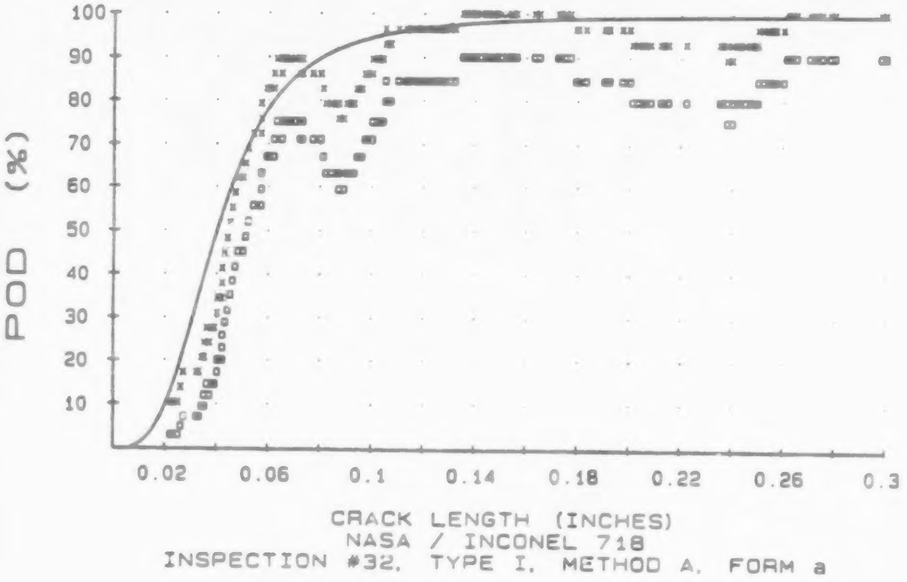


Inspection #32
Inconel 718
110 Specimens
281 Cracks
81.1% Detected
3 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-18
POD Curves for Inspection #32 Performed with Type I, Method A, Sensitivity Level 3 Penetrant and Dry Developer

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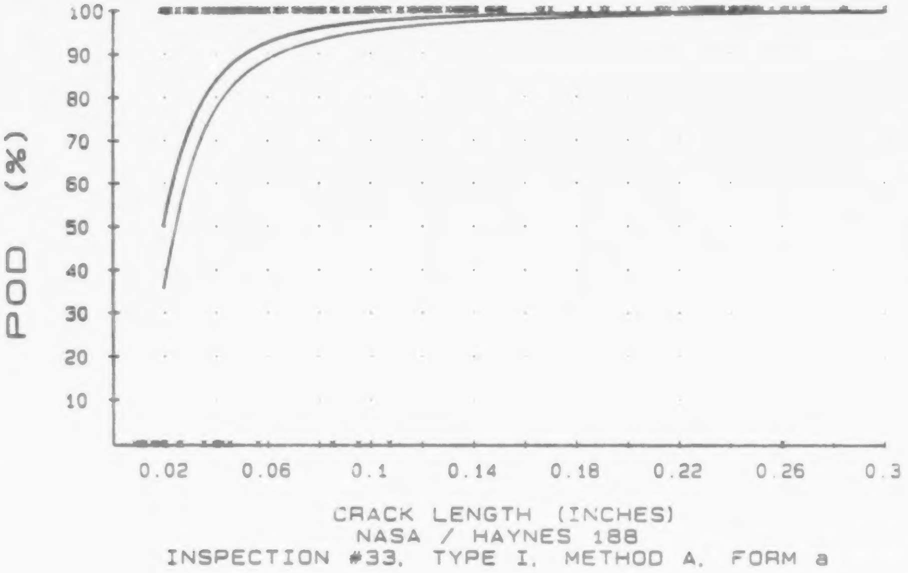
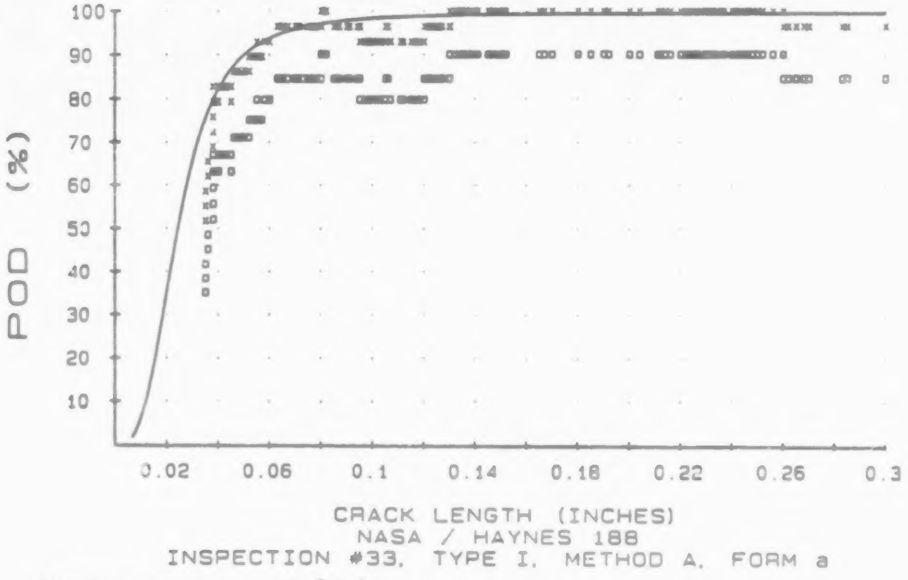


Inspection #33
Haynes 188
102 Specimens
284 Cracks
91.5% Detected
0 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-19
POD Curves for Inspection #33 Performed with Type I, Method A, Sensitivity Level 3 Penetrant and Dry Developer

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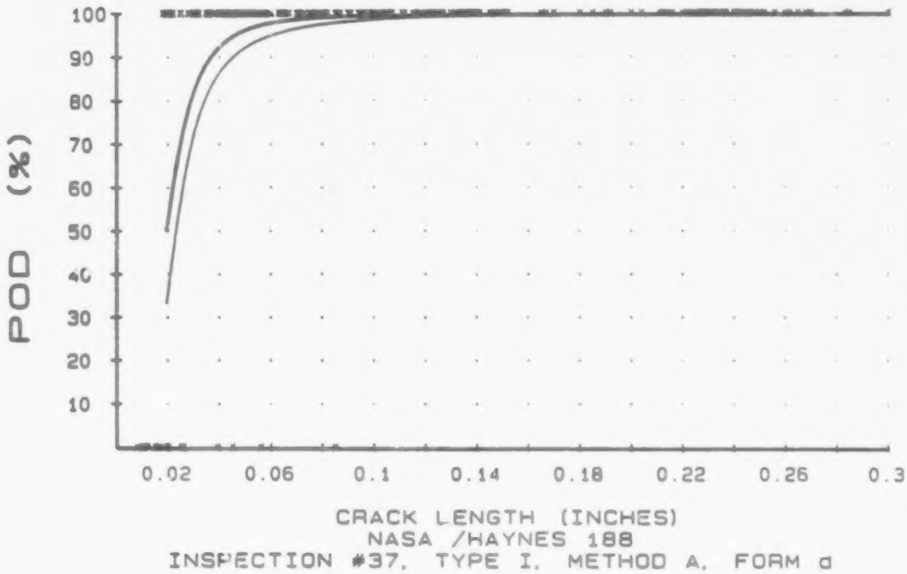
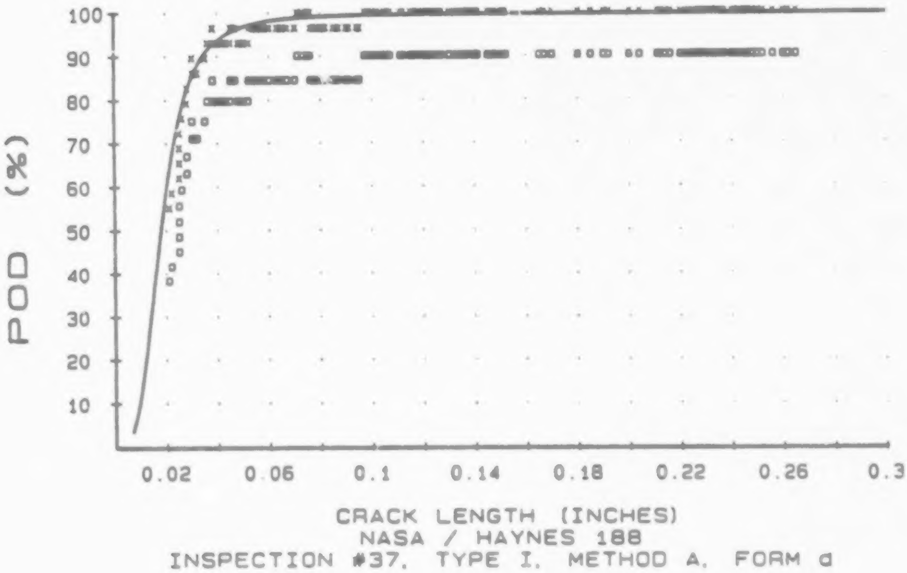


Inspection #37
Haynes 188
102 Specimens
284 Cracks
94.0% Detected
4 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-20
POD Curves for Best Individual Performance for Inspection Performed with Type I, Method A, Sensitivity Level 3 Penetrant and Nonaqueous Developer

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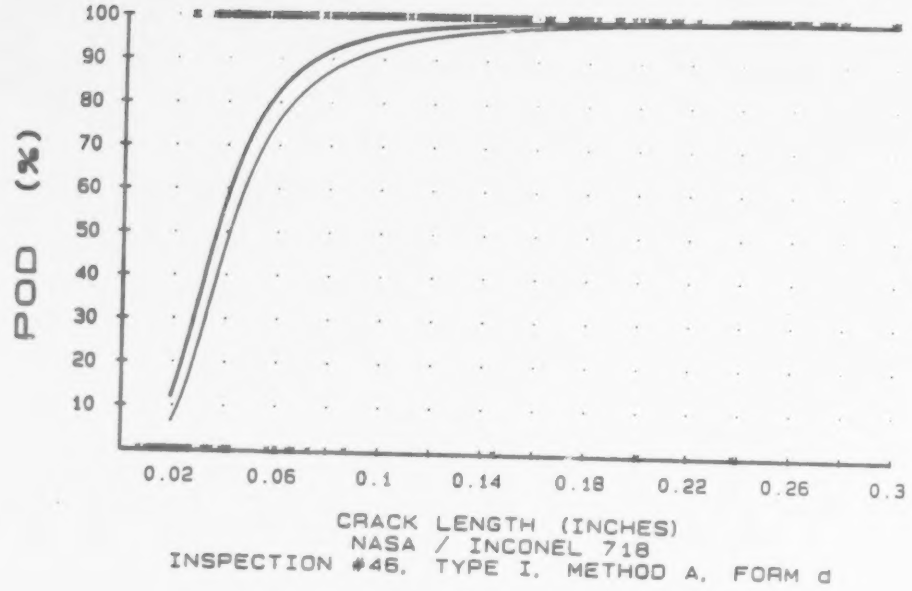
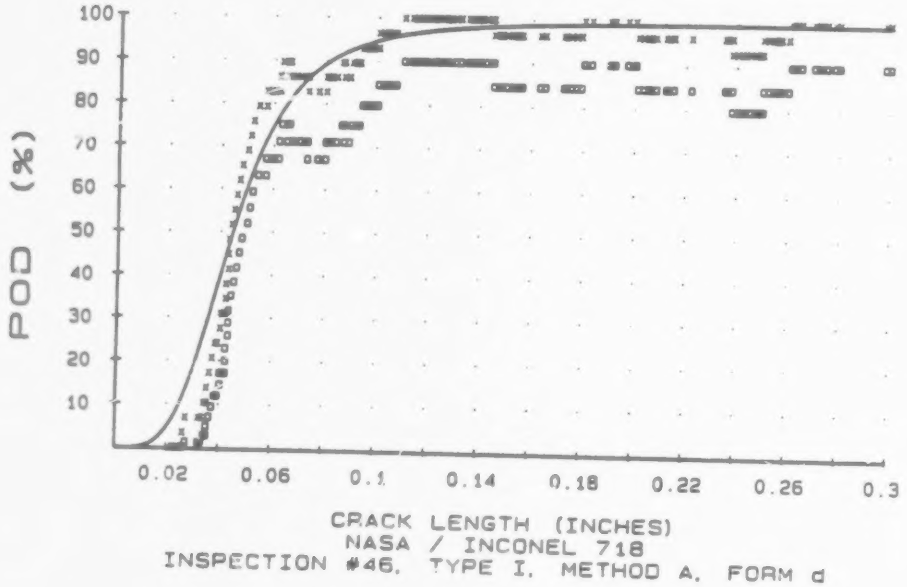


Inspection #46
Inconel 718
110 Specimens
281 Cracks
81.5% Detected
1 False Call

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-21
POD Curves for Worst Individual Performance for Inspection Performed with Type I, Method A, Sensitivity Level 3 Penetrant and Nonaqueous Developer

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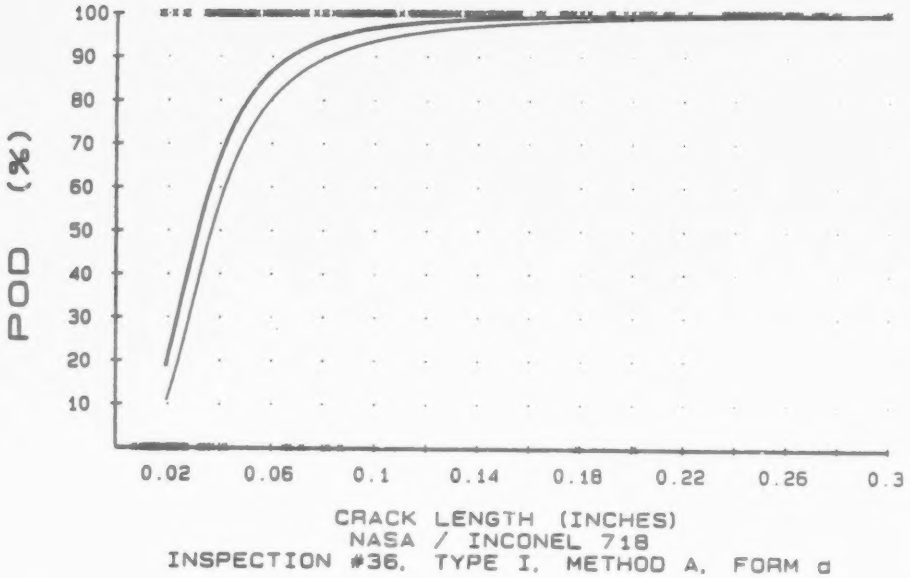
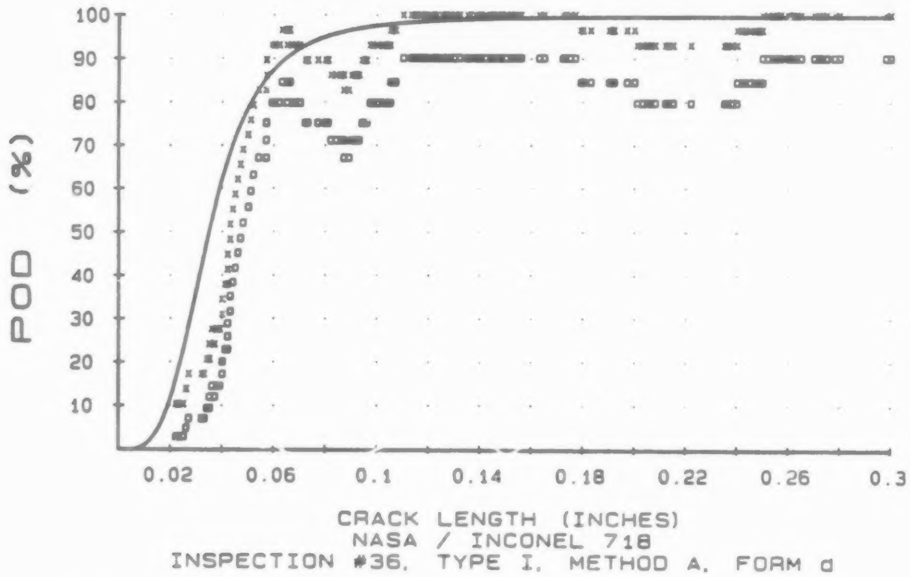


Inspection #36
Inconel 718
110 Specimens
281 Cracks
83.6% Detected
6 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-22
POD Curves for Median Individual Performance for Inspection Performed with Type I, Method A, Sensitivity Level 3 Penetrant and Nonaqueous Developer

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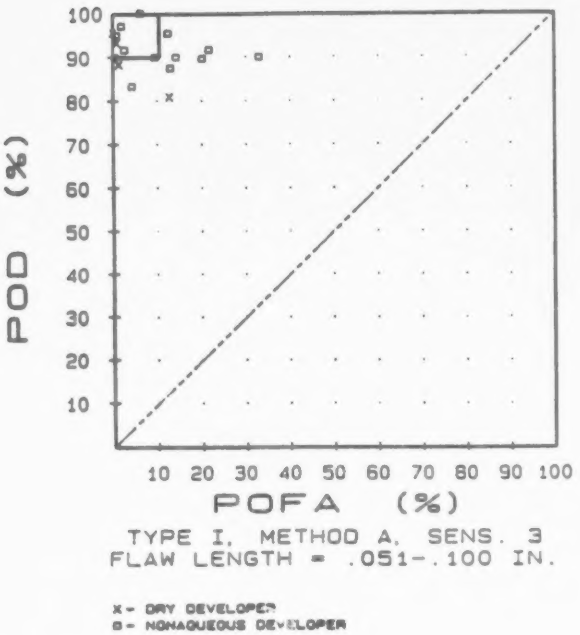

Figure 5-23
Modified ROC Analysis for Inspections Performed with Type I, Method A, Sensitivity Level 3 Penetrant (0.051-0.100 in. Flaw Length Range)

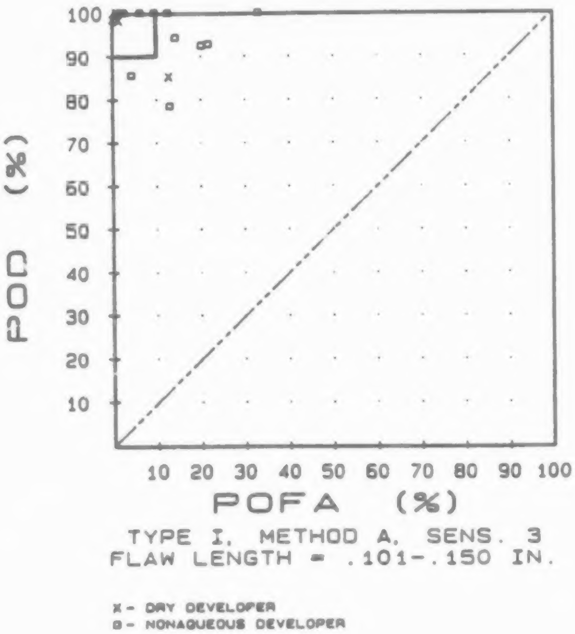

Figure 5-24
Modified ROC Analysis for Inspections Performed with Type I, Method A, Sensitivity Level 3 Penetrant (0.101-0.150 in. Flaw Length Range)

The nonaqueous developers used in conjunction with the Sensitivity Level 3 water washable penetrants provided some improvement in flaw detection over the dry developers (88.5% average detection versus 85.6%), but the nonaqueous inspections also resulted in a higher false call rate (10.8% versus 3.8%).

5.1.3 Type I, Method C Penetrant Inspections

Five solvent removable (Method C) fluorescent penetrant inspections were performed with Sensitivity Level 3 penetrants as listed by QPL-25135-15. For each of these inspections, nonaqueous (Form d) developer was used. The solvent removable inspection sequences completed during the NDI reliability program are described in Table 5-6.

All inspections were performed by hand processing the specimens. Penetrant was applied by brush or foam tip applicator and allowed to dwell on the specimen surfaces 10 to 20 min. before excess penetrant was removed from the specimens by wiping with rags or Kim-Wipes. The remaining penetrant was removed by applying the solvent remover to a cotton pad or rag and wiping the specimens under blacklight until clean. The nonaqueous wet developer was applied from aerosol cans. Flaw indications were allowed to develop from 0 to 10 min. before the inspectors examined the specimens.

Table 5-6
Solvent Removable (Method C) Fluorescent Penetrant Inspection Sequences

Inspection Number	Inspector Number	Test Set	Penetrant Sens. Level	Developer	Process
64	32	Haynes 188	3	Nonaqueous	Hand
65	33	Haynes 188	3	Nonaqueous	Hand
66	34	Inconel 718	3	Nonaqueous	Hand
67	35	Inconel 718	3	Nonaqueous	Hand
68	36	Inconel 718	3	Nonaqueous	Hand

POD curves for the best, worst and median individual performances are shown in Figures 5-25 through 5-27. POD curves for all five Type I, Method C inspections are included in Appendix B.

The results for the inspections have been summarized in Table 5-7. The overall percentage of flaws detected, the percentage of false calls, and the detection probability for the 4 crack length ranges are listed.

Modified ROC diagrams for the 0.050-0.100 in. and 0.101-0.150 in. flaw length ranges are shown in Figures 5-28 and 5-29.

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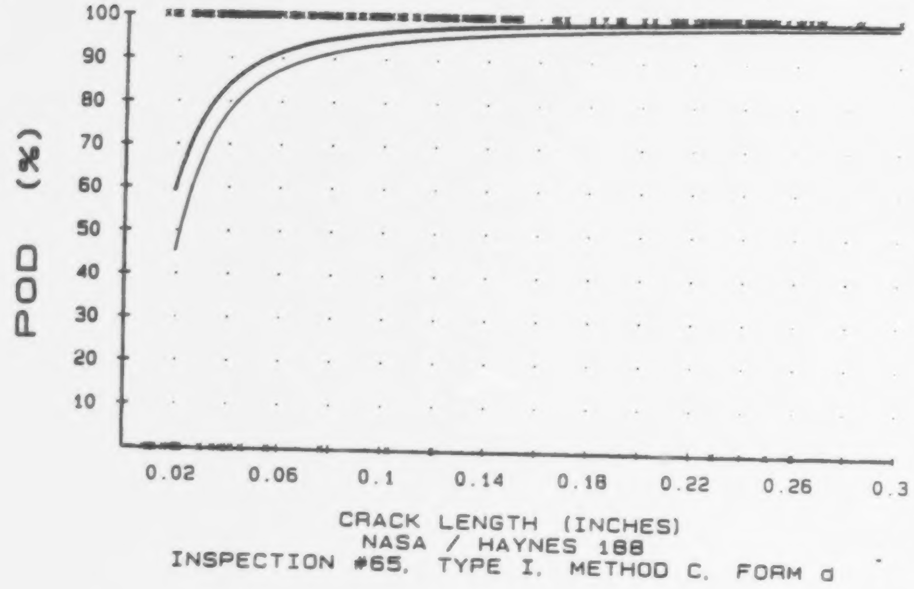
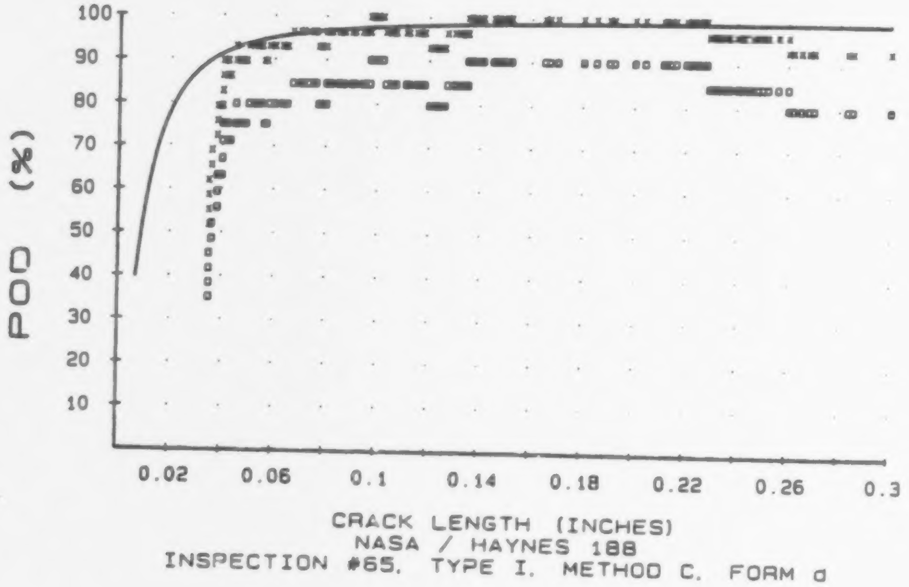


Inspection #65
Haynes 188
102 Specimens
284 Cracks
91.5% Detected
37 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-25
POD Curves for Best Individual Performance for Inspection Performed with Type I, Method C Penetrant

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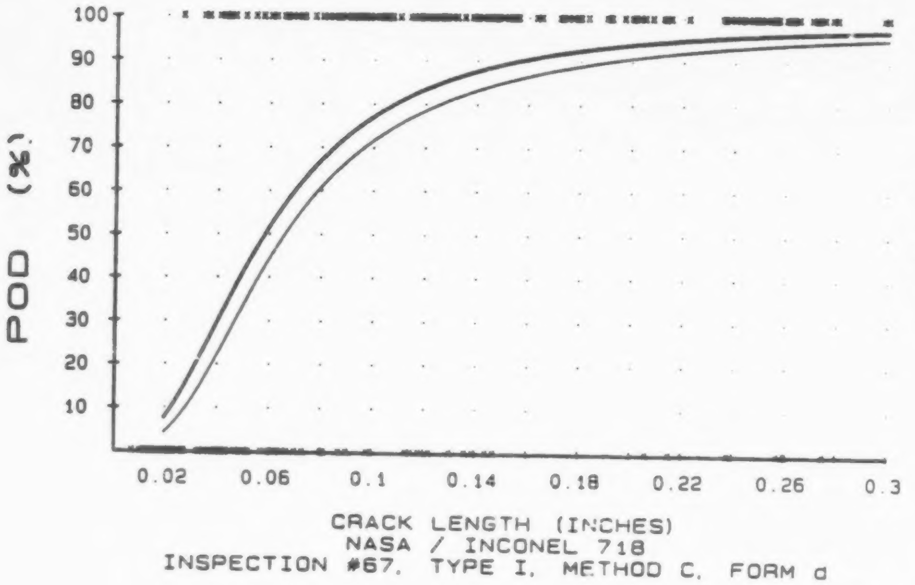
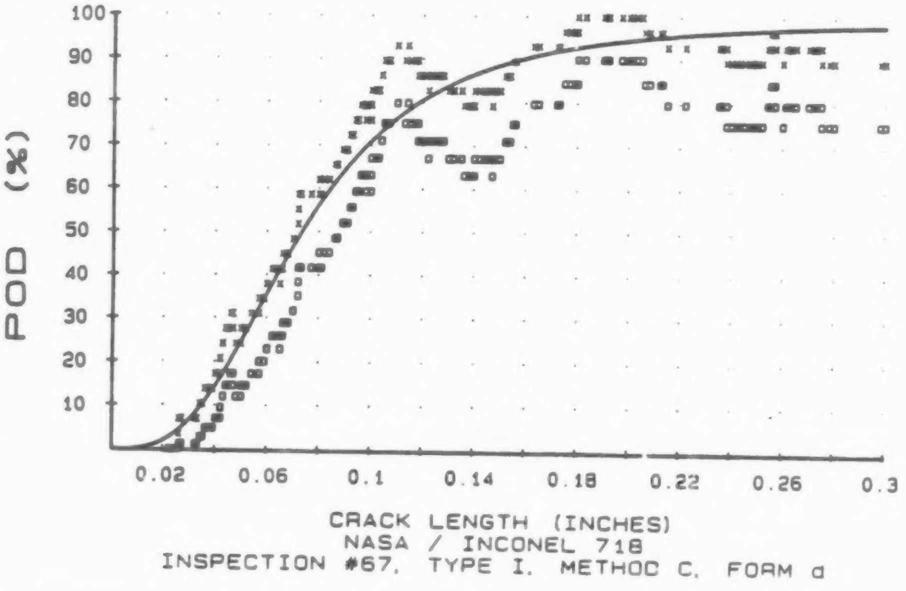


Inspection #67
Inconel 718
110 Specimens
281 Cracks
68.3% Detected
3 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-26
POD Curves for Worst Individual Performance for Inspection Performed with Type I, Method C Penetrant

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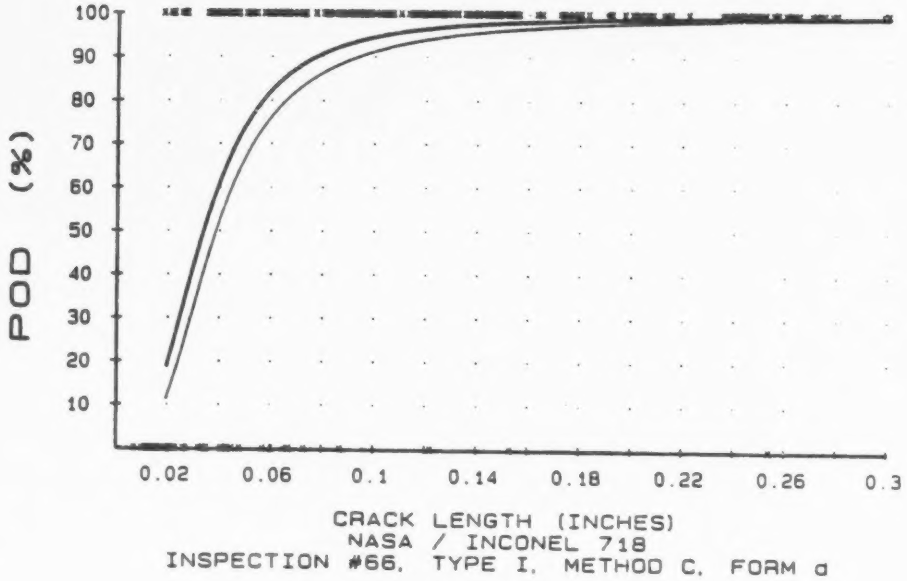
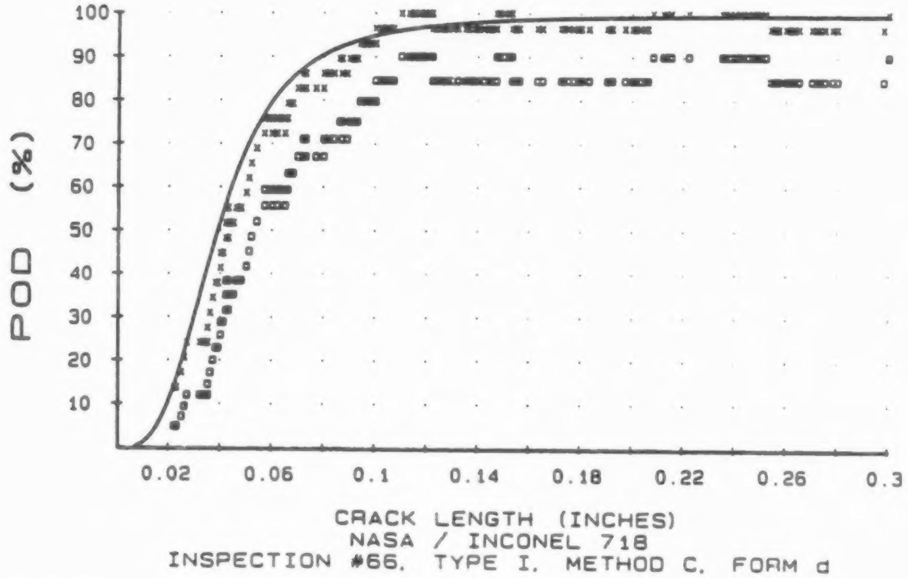


Inspection #66
Inconel 718
110 Specimens
281 Cracks
82.2% Detected
12 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-27
POD Curves for Median Individual Performance for Inspection Performed with Type I, Method C Penetrant

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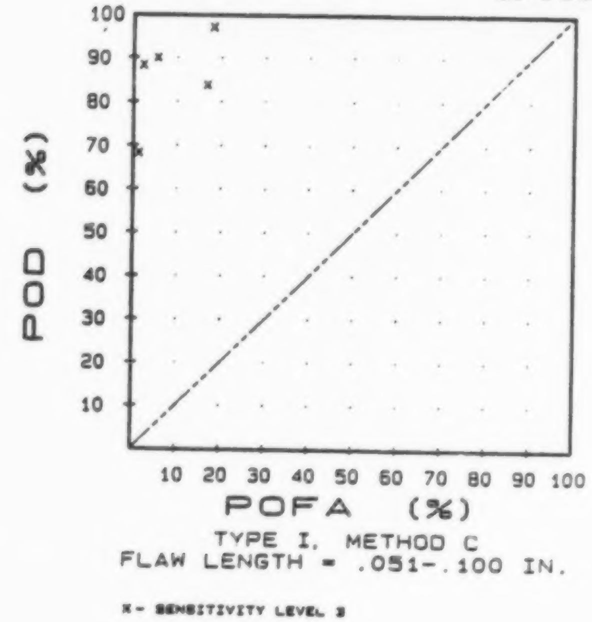

Figure 5-28
Modified ROC Analysis for Inspections Performed with Type I, Method C Penetrant (0.051-0.100 in. Flaw Length Range)

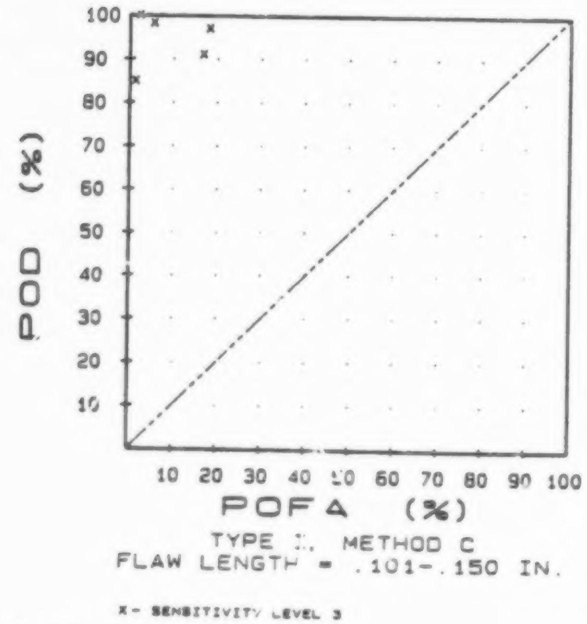

Figure 5-29
Modified ROC Analysis for Inspections Performed with Type I, Method C Penetrant (0.101-0.150 in. Flaw Length Range)

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Table 5-7
Summary of Type I, Method C, Sensitivity Level 3 Penetrant Inspection Results

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
64	84.9	16.7	64.6%(53.7%)	83.8%(74.7%)	91.2%(83.3%)	96.7%(89.9%)
65	91.5	18.1	75.4%(65.1%)	97.1%(91.0%)	97.1%(91.0%)	96.7%(89.9%)
66	82.2	5.5	38.1%(27.8%)	90.0%(81.2%)	98.3%(92.4%)	98.3%(92.4%)
67	68.3	1.4	15.9%(8.9%)	68.3%(57.1%)	85.0%(75.3%)	95.0%(87.6%)
68	82.5	2.3	39.7%(29.5%)	88.3%(79.2%)	100.0%(95.1%)	98.3%(92.4%)
Ave.	81.9	8.8	46.7%(37.0%)	85.5%(76.6%)	94.3%(87.4%)	97.0%(90.4%)

Some of the factors that were observed that adversely effected the Type I, Method C inspection results included insufficient indication bleed-out time after applying the developer, over-saturation of the cleaning rags or cotton pads with remover, and low-intensity blacklights. In general, though, the inspectors demonstrated knowledge of the process and performed the inspections within accepted penetrant processing limits. The largest variations in processing observed for the solvent removable inspections was the amount of solvent used to dampen the cleaning rags. Some inspectors used very little solvent while others used enough solvent to get the rags thoroughly wet. Another significant variable was the thickness of the developer coating applied. The amount of nonaqueous developer applied is to some extent a matter of personal preference, but at either extreme the detection capabilities of the process are hindered. Extremely light developer applications will not fully develop flaw indications and limit their brightness. Excessively heavy developer application can actually cover-up flaw indications making them impossible to detect.

5.1.4 Type I, Method D Penetrant Inspections

Seventeen post-emulsifiable fluorescent penetrant inspections were performed using hydrophilic remover (Type I, Method D). Three of these (Inspections #47-#49), were performed using Sensitivity Level 3 penetrants listed by QPL-25135-15 and soluble wet developer (Form b). The remaining 14 inspections (Inspections #50-#63) were performed with penetrants listed as Sensitivity Level 4 by QPL-25135-15 and either dry powder developer (Form a) or soluble wet developer (Form b). Table 5-8 lists the 17 post emulsifiable penetrant inspections with the test sets, materials and processing methods used.

The inspections were performed on manual dip tank or spray penetrant processing lines or automated spray processing lines. The penetrant dwell times for the post emulsifiable penetrant inspections ranged from 20 to 60 min. Indication bleed-out times ranged from 10 to 20 min.

Table 5-8
Post-Emulsifiable (Method D) Penetrant Inspection Sequences

Inspection Number	Inspector Number	Test Set	Penetrant Sens. Level	Developer	Process
47	25	Inconel 718	3	Wet	Dip Tank
48	25	Inconel 718	3	Wet	Spray
49	25	Inconel 718	3	Wet	Dip Tank
50	26	Haynes 188	4	Dry	Auto Spray
51	27	Haynes 188	4	Dry	Auto Spray
52	28	Inconel 718	4	Dry	Auto Spray
53	29	Haynes 188	4	Dry	Auto Spray
54	30	Inconel 718	4	Dry	Auto Spray
55	31	Haynes 188	4	Dry	Auto Spray
56	28	I718 Sbst B	4	Dry	Spray
57	29	H188 Sbst B	4	Dry	Spray
58	26	H188 Sbst A	4	Dry	Auto Spray
59	49	Haynes 188	4	Wet	Dip Tank
60	50	Haynes 188	4	Wet	Auto Spray
61	51	Haynes 188	4	Wet	Auto Spray
62	52	Haynes 188	4	Wet	Dip Tank
63	53	Haynes 188	4	Wet	Dip Tank

Proper emulsification was a concern for the majority of the post-emulsifiable penetrant inspections that were performed during this program. Problems that were observed included excessive emulsification times resulting in over emulsification of the penetrant, insufficient emulsification times resulting in a high fluorescent background on the test specimens, and concentrations of hydrophilic remover exceeding manufacturer's recomendations resulting in over emulsification and weak crack indication brightnesses.

5.1.4.1 Sensitivity Level 3, Type I, Method D Inspections--Inspection #47 was performed on a manual dip tank line containing concentrated hydrophilic remover. Inspection #48 was performed on a manual spray line using a remover concentration of 10%. Both of these remover concentrations exceed the manufacturer's recommended levels for the method of application. The manufacturer's recommended concentration range for dip application is 5 - 35% remover in water. For spray application the recommended concentration range is 0.1 to 0.5% remover in water. The emulsification times used for these two inspections ranged from 2 to 3 min. for Inspection #47 and from 8 to 20 min. for Inspection #48. The emulsification times in combination with the remover concentration levels resulted in over-removal of penetrant and decreased inspection sensitivity. The POD curves for Inspections #47 and #48 are shown in Figures 5-30 and 5-31.

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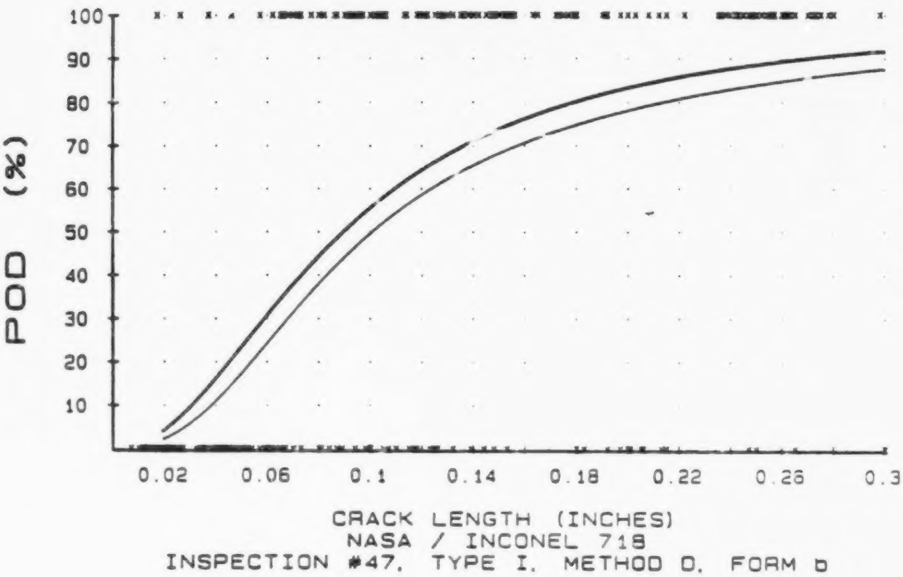
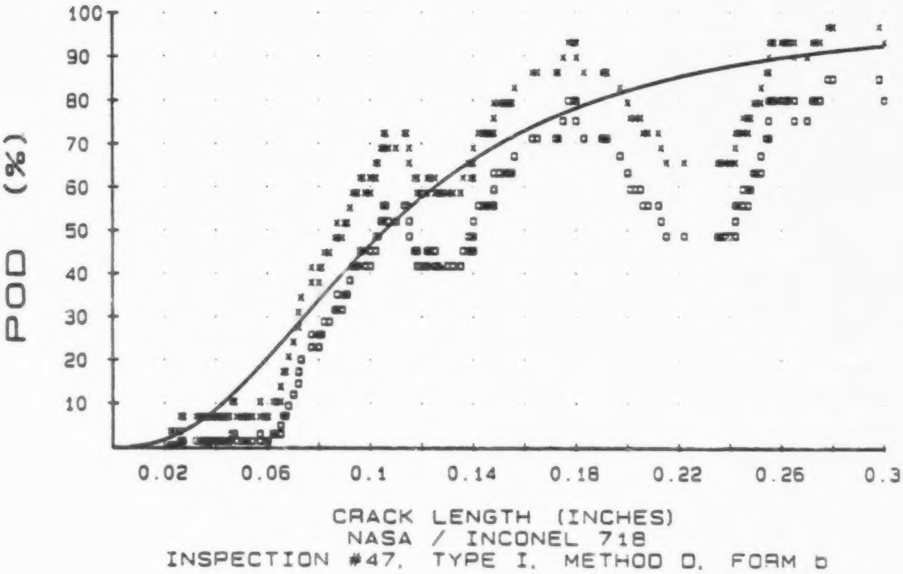


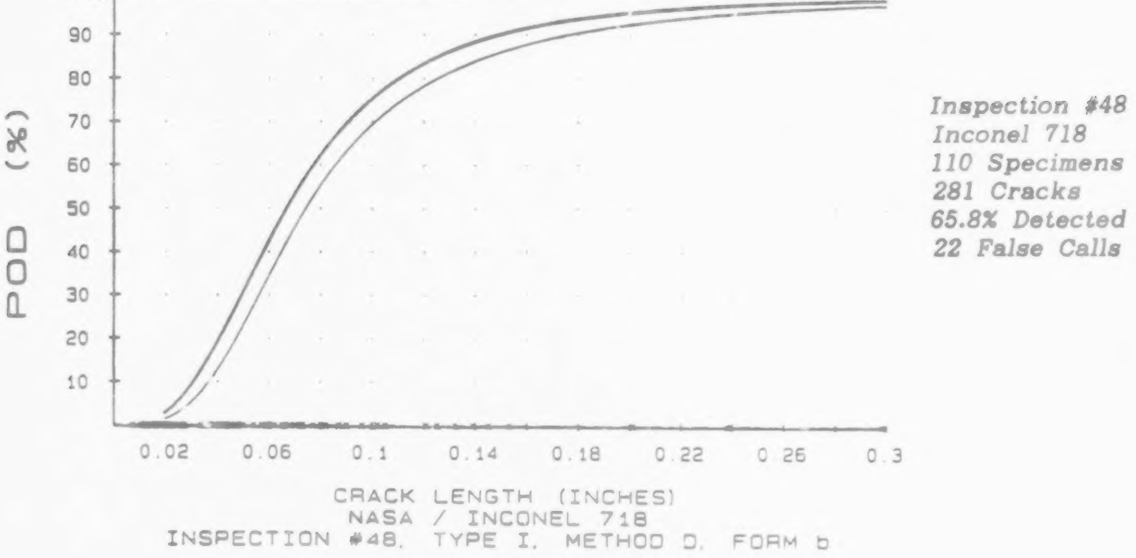
Inspection #47
Inconel 718
110 Specimens
281 Cracks
54.8% Detected
33 False Calls

Maximum Likelihood Analysis

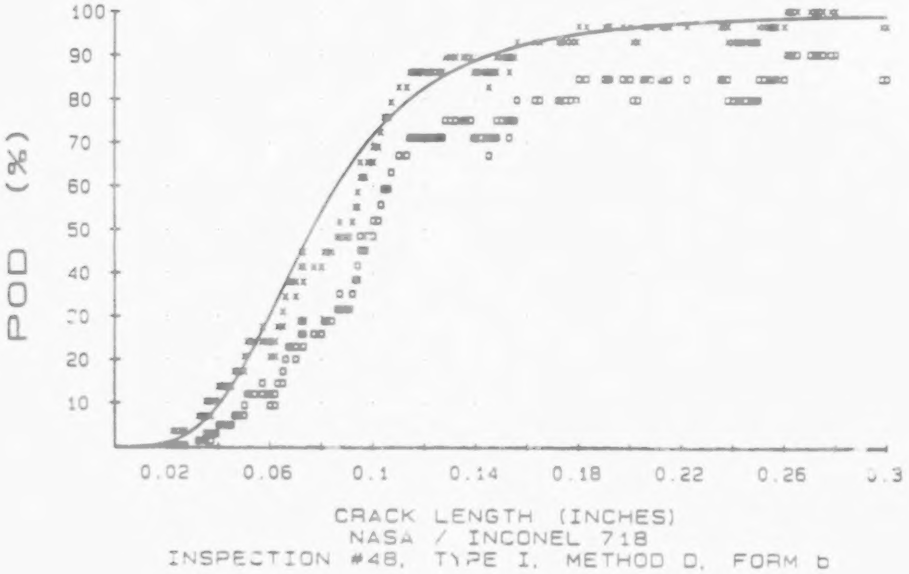


Moving Average Analysis

Figure 5-30
POD Curves for Inspection #47 Performed with Type I, Method D, Sensitivity Level 3 Penetrant



Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-31
POD Curves for Inspection #48 Performed with Type I, Method D, Sensitivity Level 3 Penetrant

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To illustrate the effect over-removal of penetrant had on Inspections #47 and #48, Inspection #49 was performed on the manual dip tank line, after reducing the remover concentration to 20%, using the same operator that performed Inspection #47. The emulsification time was reduced to 45 sec. and was closely monitored to prevent over emulsification. The POD curve for this inspection is shown in Figure 5-32 and shows a significant improvement in performance. The modified ROC diagrams showing the results for Inspections #47 to #49 for the 0.051 to 0.100 in. and the 0.101 to 0.150 in. crack length ranges are shown in Figures 5-33 and 5-34. The results of the Sensitivity Level 3 post-emulsifiable penetrant inspections are summarized in Table 5-9.

The average detection percentage for the inspections performed with the concentrated remover and extended emulsification times (Inspections #47 and #48) was 60.3%. After reducing the remover concentration and emulsification time, detection increased to over 80%.

Table 5-9
Summary of Type I, Method D Sensitivity Level 3 Penetrant Inspection Results

Insp. No.	% Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit) .010-.050	.051-.100	.101-.150	.151-.250
47	54.8	15.0	6.3%(2.2%))	46.7%(35.5%)	70.0%(58.8%)	78.3%(67.9%)
48	65.8	10.0	11.1%(5.3%)	55.0%(43.6%)	88.3%(79.2%)	95.0%(87.6%)
49	80.4	12.7	34.9%(25.0%)	88.3%(79.2%)	96.7%(89.9%)	96.7%(89.9%)
Ave.	67.0	12.6	17.4%(10.8%)	63.3%(52.8%)	85.0%(76.0%)	90.0%(81.8%)

5.1.4.2 Sensitivity Level 4, Type I, Method D Inspections--The Sensitivity Level 4 post emulsifiable penetrant inspections were performed on manual spray or dip tip tank lines, or automated spray lines. As with the Sensitivity Level 3 penetrants, emulsifier/remover application contributed significantly to the performance demonstrated by the Sensitivity Level 4 penetrant inspections.

Inspections #50-#55, and #58-#59 were performed with remover concentrations ranging from 36% to 50%, exceeding the manufacturer's recommended concentration range of 20-33% for dip tank applications. With the exception of Inspection #59 these inspections were performed on an automated spray line where the remover was applied by a flood type spray that provided more mechanical wash action than normally obtained in a dip tank, contributing further to the over-emulsification of the penetrant. The emulsification times for these inspections were 3 min. for Inspections #50 and #51; 90 sec. for Inspections #52-#55, and #58; and 30 sec. for Inspection #59. The reduced emulsification time used for Inspection #59 compensated for the high remover concentration to some degree. However, over emulsification contributed significantly to the flaw detection capability demonstrated by the remainder of these inspections.

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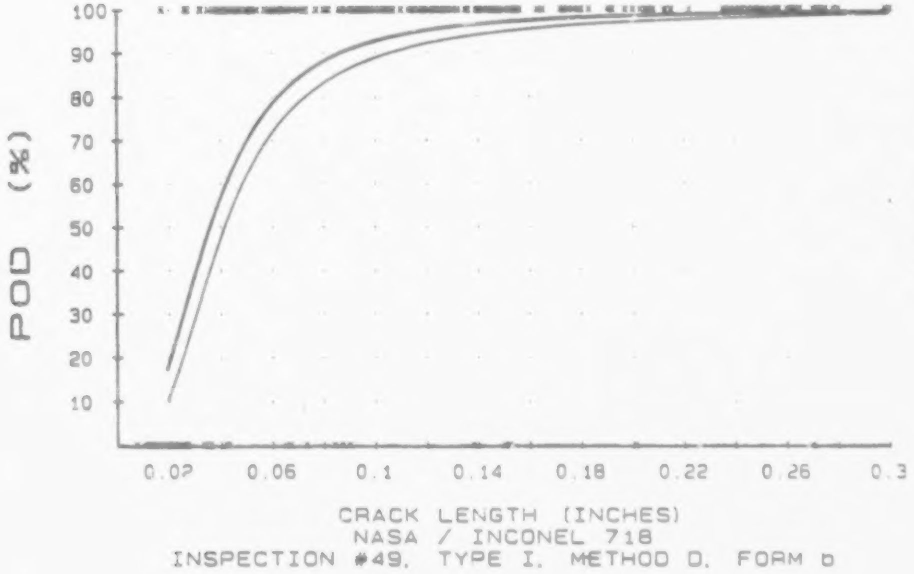
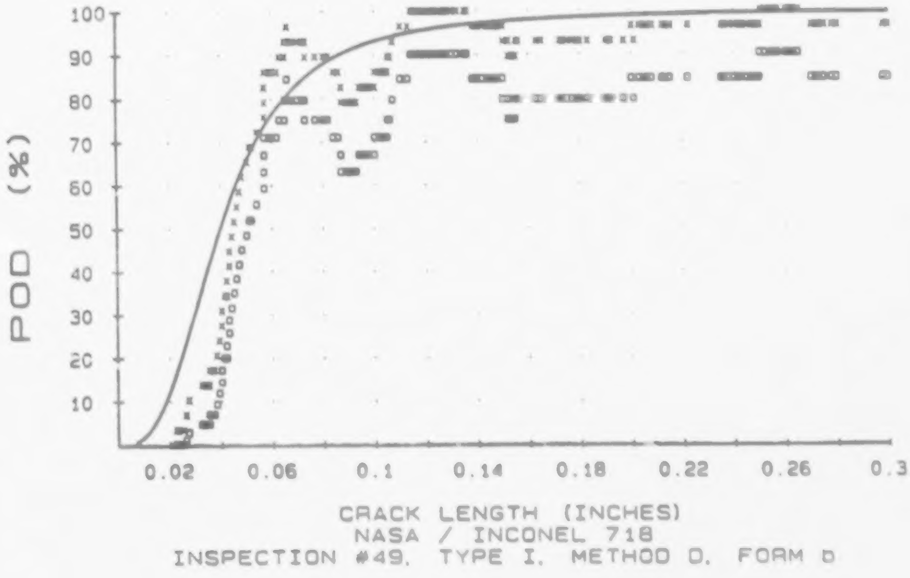


Inspection #49
Inconel 718
110 Specimens
281 Cracks
80.4% Detected
28 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-32
POD Curves for Inspection #49 Performed with Type I, Method D, Sensitivity Level 3 Penetrant

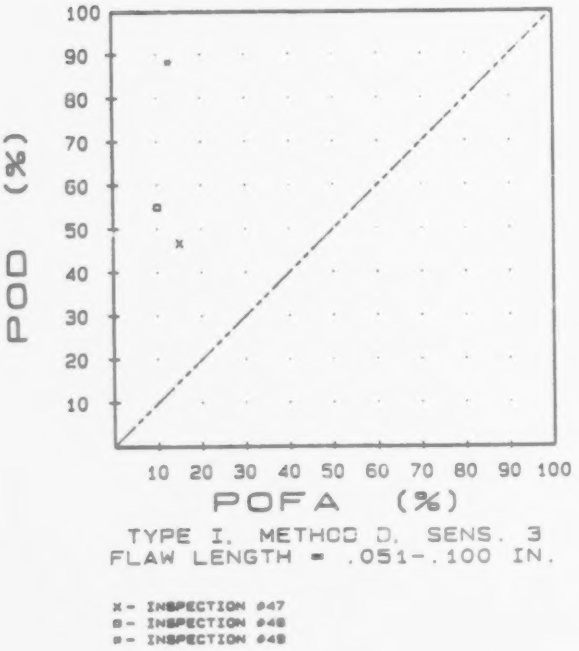


Figure 5-33
Modified ROC Analysis for Inspections Performed with Type I, Method D, Sensitivity Level 3 Penetrant (0.051-0.100 in. Flaw Length Range)

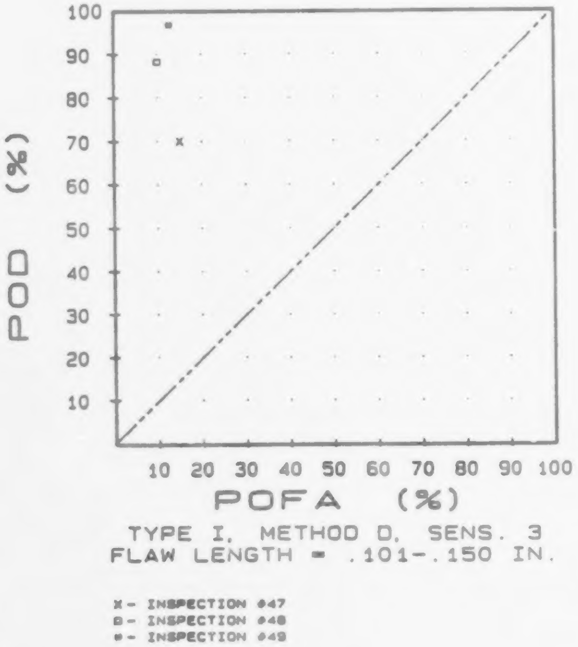


Figure 5-34
Modified ROC Analysis for Inspections Performed with Type I, Method D, Sensitivity Level 3 Penetrant (0.101-0.150 in. Flaw Length Range)

The POD curves for the best, worst, and median individual performances for the Sensitivity Level 4, post-emulsifiable penetrant inspections are shown in Figures 5-35 through 5-37. The modified ROC diagrams for the 0.051 - 0.100 in. and 0.101 - 0.150 in. flaw length ranges are shown in Figures 5-38 and 5-39. The results from the Sensitivity Level 4 inspections are summarized in Table 5-10.

Table 5-10
Summary of Type I, Method D, Sensitivity Level 4 Penetrant Inspection Results

Insp. No.	% Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
50	73.6	5.9	44.6%(34.1%)	75.0%(64.9%)	76.5%(66.5%)	91.7%(83.3%)
51	67.6	3.9	38.5%(28.3%)	66.2%(55.6%)	73.5%(63.3%)	85.0%(75.3%)
52	78.3	4.1	36.5%(26.4%)	80.0%(69.6%)	93.3%(85.4%)	95.0%(87.6%)
53	78.5	1.5	49.2%(38.5%)	77.9%(68.1%)	91.2%(83.3%)	95.0%(87.6%)
54	81.5	3.6	38.1%(27.8%)	86.7%(77.2%)	96.7%(89.1%)	98.3%(92.4%)
55	56.0	8.3	11.7%(5.6%)	57.1%(46.0%)	65.1%(54.0%)	90.0%(81.2%)
56	88.6	4.3	68.4%(-----)	90.0%(-----)	100.0%(-----)	100.0%(-----)
57	79.4	2.6	56.2%(-----)	80.0%(-----)	88.2%(-----)	92.9%(-----)
58	82.4	5.0	64.7%(-----)	82.6%(-----)	84.6%(-----)	100.0%(-----)
59	81.3	4.9	50.8%(40.0%)	83.8%(74.7%)	95.6%(89.0%)	93.3%(85.4%)
60	75.0	100.0	32.3%(22.7%)	80.9%(71.3%)	86.8%(78.0%)	95.0%(87.6%)
61	76.8	100.0	35.4%(25.5%)	79.4%(69.7%)	95.6%(89.0%)	95.0%(87.6%)
62	85.6	2.9	63.1%(52.2%)	89.7%(81.5%)	92.6%(85.5%)	90.0%(81.2%)
63	79.9	29.4	61.5%(50.6%)	82.4%(73.0%)	83.8%(74.7%)	90.0%(81.2%)
Ave.	77.2	19.7	46.5%(32.0%)	79.4%(68.3%)	87.4%(78.0%)	93.7%(84.6%)

Inspections #50-#55, and #58-#59 were performed with remover concentrations ranging from 36% to 50%, exceeding the manufacturer's recommended concentration range of 20-33% for dip tank applications. With the exception of Inspection #59 these inspections were performed on an automated spray line where the remover was applied by a flood type spray that provided more mechanical wash action than normally obtained in a dip tank, contributing further to the over-emulsification of the penetrant. The emulsification times for these inspections were 3 min. for Inspections #50 and #51; 90 sec. for Inspections #52-#55, and #58; and 30 sec. for Inspection #59. The reduced emulsification time used for Inspection #59 compensated for the high remover concentration to some degree. However, over emulsification contributed significantly to the flaw detection capability demonstrated by the remainder of these inspections.

Inspections #60 and #61 were performed on an automated spray line that used a true spray emulsifier application. The emulsifier spray time was controlled by the speed of the parts conveyor and was fixed at 30 sec. The low emulsifier concentration used for the spray application and the 30 sec. spray duration was insufficient to fully emulsify the penetrant leaving a high fluorescent background on the parts. As a result, the number of false calls for these two inspections exceeded the number of panel sides inspected for a 100% false call rate.

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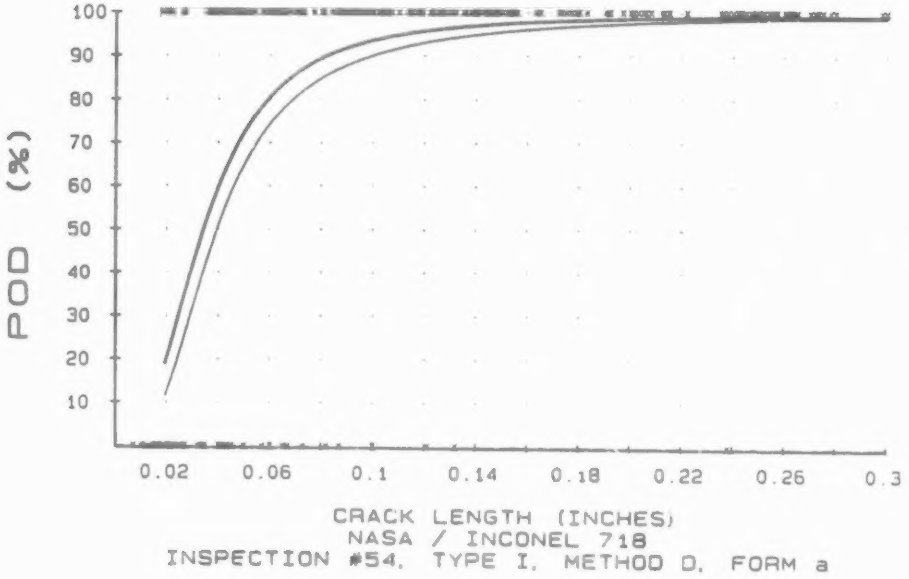
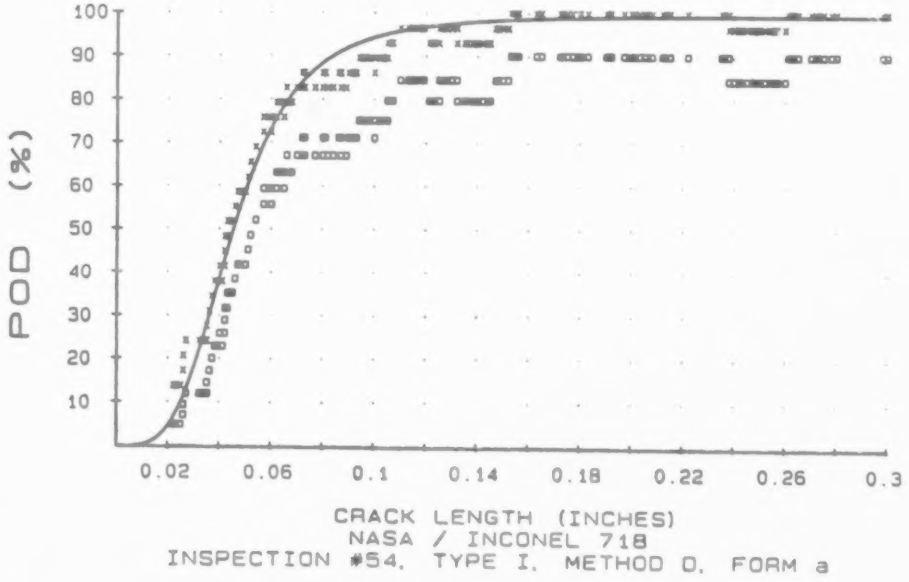


Inspection #54
Inconel 718
110 Specimens
281 Cracks
81.5% Detected
8 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-35
POD Curves for Best Individual Performance for Inspection Performed with Type I, Method D, Sensitivity Level 4 Penetrant

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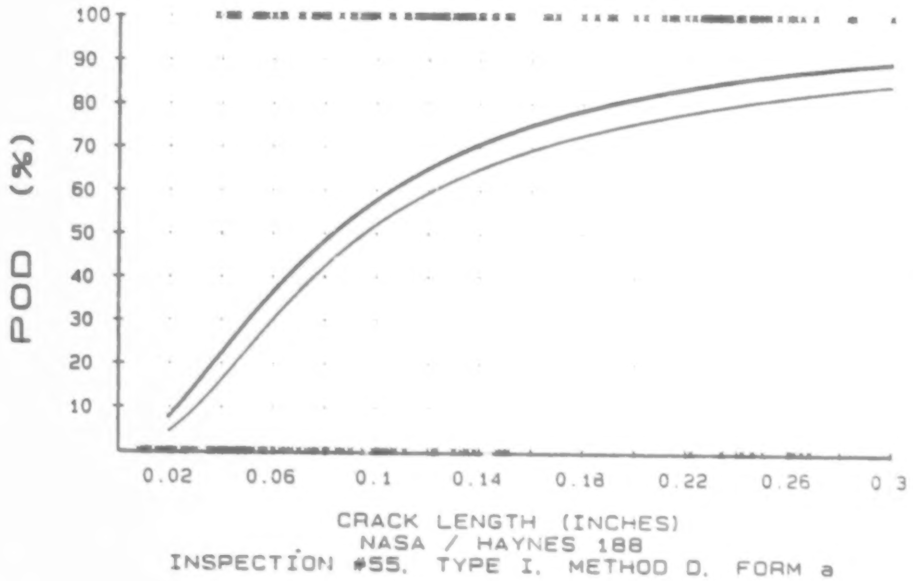
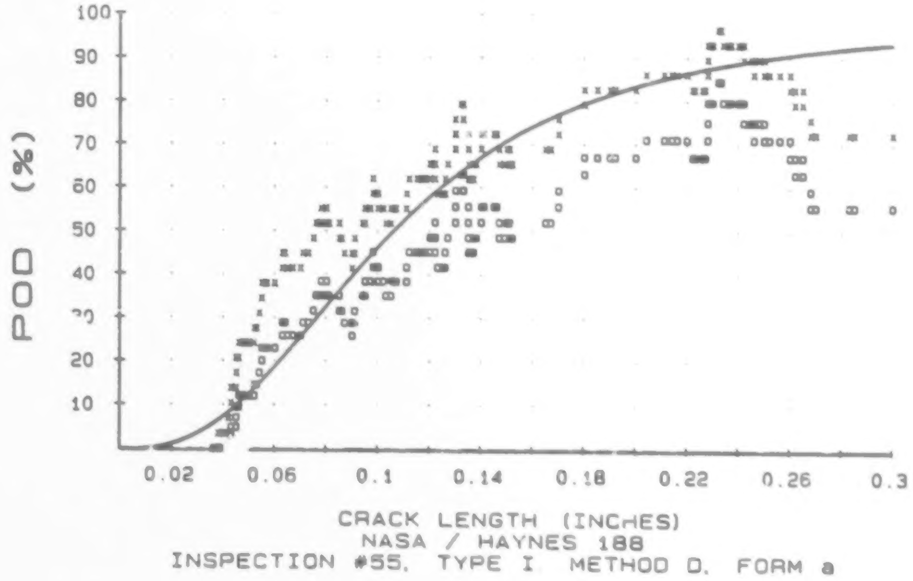


Inspection #55
Haynes 188
102 Specimens
284 Cracks
56.0% Detected
17 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-36
POD Curves for Worst Individual Performance for Inspection Performed with Type I, Method D, Sensitivity Level 4 Penetrant

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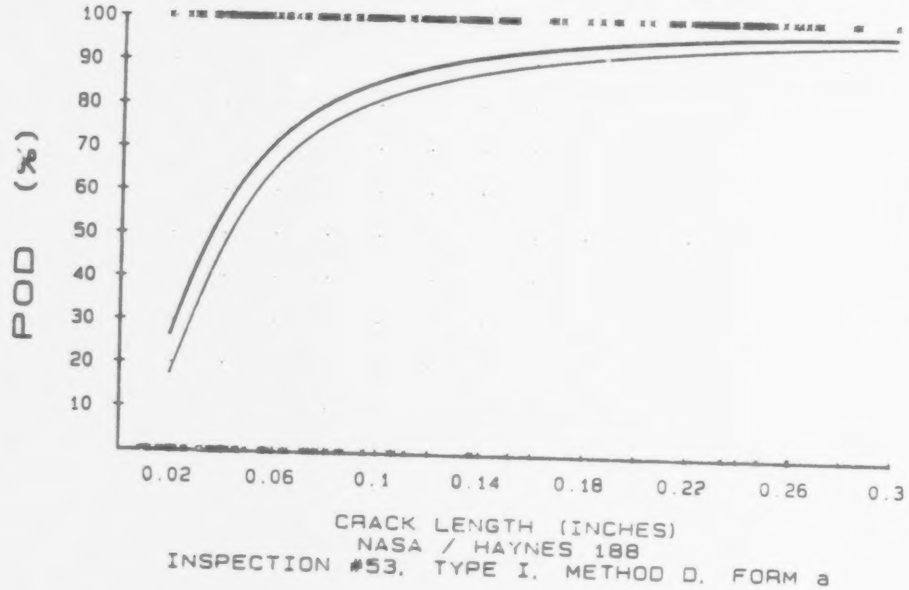
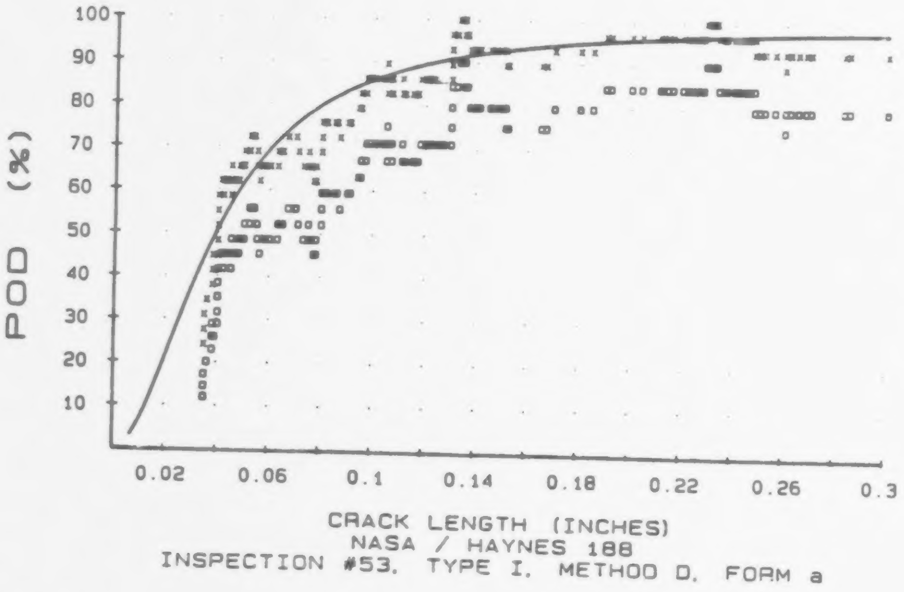


Inspection #53
Haynes 188
102 Specimens
284 Cracks
78.5% Detected
3 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-37
POD Curves for Median Individual Performance for Inspection Performed with Type I, Method D, Sensitivity Level 4 Penetrant

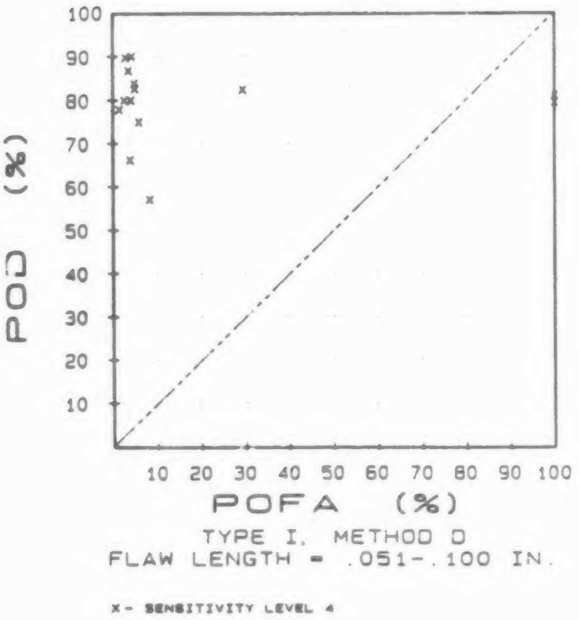


Figure 5-38
Modified ROC Analysis for Inspections Performed with Type I, Method D, Sensitivity Level 4 Penetrant (0.051-0.100 in. Flaw Length Range)

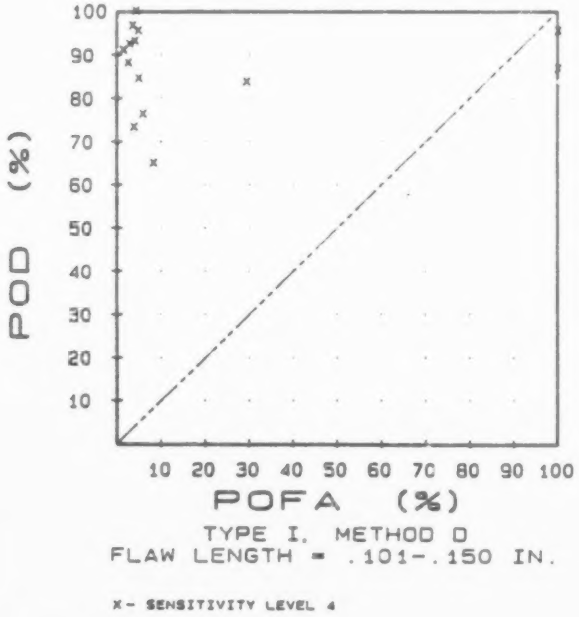


Figure 5-39
Modified ROC Analysis for Inspections Performed with Type I, Method D, Sensitivity Level 4 Penetrant (0.101-0.150 in. Flaw Length Range)

The high false call rate for Inspection #63 (29.4%) was caused by contamination of the wet developer bath with penetrant.

Because of the problems encountered with emulsification and the choice of developers (soluble wet and dry powder), the performance exhibited by the Sensitivity Level 4, post-emulsifiable penetrant inspections was below that demonstrated by the lower sensitivity water-wash penetrants evaluated during this program. Post-emulsifiable penetrant systems can provide additional flaw detection sensitivity, but only if the remover concentrations and emulsification times are optimized on a case by case basis and are carefully controlled.

5.1.5 Type II, Method A and C Penetrant Inspections

Six Type II, visible penetrant inspections were performed during the NDI reliability assessment program. One inspection was completed using a water-washable (Method A) penetrant (Inspection #69) and 5 inspections were completed using the solvent-removable method (Method C) (Inspections #70-#74). The test sets and processing methods used for these inspections are listed in Table 5-11.

Table 5-11
Visible (Type II) Penetrant Inspection Sequences

Inspection Number	Inspector Number	Test Set	Method	Developer	Process
69	37	Inconel 718	A	Nonaqueous	Hand
70	38	Inconel 718	C	Nonaqueous	Hand
71	39	Haynes 188	C	Nonaqueous	Hand
72	40	Inconel 718	C	Nonaqueous	Hand
73	41	Haynes 188	C	Nonaqueous	Hand
74	42	Inconel 718	C	Nonaqueous	Hand

5.1.5.1 Type II, Method A Inspection--The water-washable, red-visible penetrant (Inspection #69) was applied to the test specimens by brushing the penetrant onto both sides of each specimen. The inspector applied penetrant to a full rack (8 specimens) at one time. The specimens were then allowed to drain/dwell for approximately 10 min. The facility penetrant processing specifications required a dwell time of a minimum of 2 min. The excess penetrant was washed from the part surfaces using a course water spray at 35 to 40 psi and a water temperature of 75 deg. F. The inspector removed the specimens from the racks and washed them individually, placing them in a clean rack as each panel was completed. The cleaned specimens were allowed to dry in a circulating air oven at a temperature of 140 deg. F until dry (approximately 10 min.). Nonaqueous wet developer was applied by spraying from an aerosol can.

Before inspecting the specimens, the operator allowed the flaw indications to develop or bleed-out for times ranging from 2 to 10 min. The inspector used a hand held white light with a brightness in excess of 1000 ft-candles to inspect the test specimens.

The POD curves for the Type II, Method A penetrant inspection are shown in Figure 5-40. The results from Inspection #69 are summarized in Table 5-12.

Inspection #69 was the only water-washable visible penetrant (Type II, Method A) inspection sequence completed, so it is unclear if the performance demonstrated during this inspection is representative of the detection capabilities of this process. The 1000 ft-candle light that was used during this inspection was excessively intense to the point of washing out the crack indications and making them more difficult to see. The crack indications that were present were very weak and required excellent eye acuity for detection. Additional development time would have aided the brightness of the indications.

Table 5-12
Summary of Type II, Method A and C Penetrant Inspection Results

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
69	56.6	0.0	14.3%(7.7%)	48.3%(37.1%)	76.7%(65.9%)	78.3%(67.9%)
70	79.4	0.0	31.7%(22.1%)	83.3%(73.4%)	98.3%(92.4%)	96.7%(89.9%)
71	79.4	0.5	33.3%(23.5%)	77.8%(67.5%)	100.0%(95.1%)	98.3%(92.4%)
72	75.8	2.3	22.2%(13.9%)	76.7%(65.9%)	96.7%(89.9%)	100.0%(95.1%)
73	71.5	0.5	36.9%(26.9%)	69.1%(58.6%)	83.8%(74.7%)	90.0%(81.2%)
74	74.6	1.0	50.8%(40.0%)	75.0%(64.9%)	81.0%(71.3%)	90.0%(81.2%)
Ave.	72.9	0.7	31.5%(22.4%)	71.7%(61.2%)	89.4%(81.5%)	92.2%(84.6%)

5.1.5.2 Type II, Method C Inspections--The solvent removable red visible penetrant inspections (Inspections #70-#74) were performed by processing 8 specimens at a time. The penetrant was applied to both sides of the specimens by brush and was allowed to dwell on the specimen surfaces for 30-50 min. before being removed. The specimens were wiped with dry cloths until as much excess penetrant as possible was removed. The specimens were then wiped using solvent moistened cloths to remove the remaining penetrant. Nonaqueous wet developer was applied by aerosol can. An average of 30-40 min. for flaw development was allowed before the specimens were inspected. The specimens were inspected under a white light with an intensity of 170 ft-candles.

The POD curves for the best, worst, and median individual performances using the Type II, Method C procedure are shown in Figures 5-41 through 5-43. Modified ROC diagrams showing the performance of the Type II penetrant inspections are shown in Figures 5-44 and 5-45 for the 0.051-0.100 in. and 0.101-0.150 in. flaw length ranges.

The POD curves and modified ROC diagrams show that the performance of the Type II, Method C inspections was not significantly different from that of a number of fluorescent penetrant systems. The extended development time of 30 min. minimum insured that maximum visibility of the indications was obtained prior to inspection.

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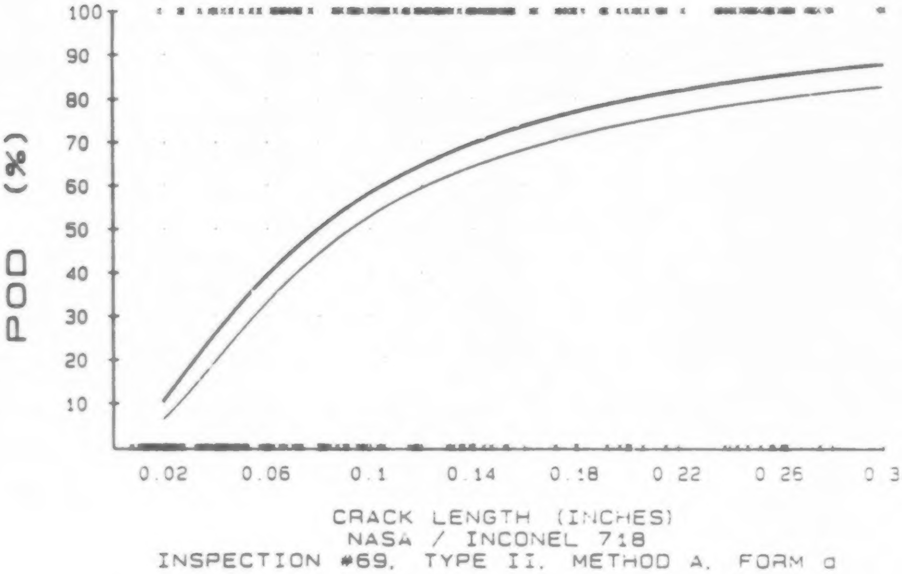
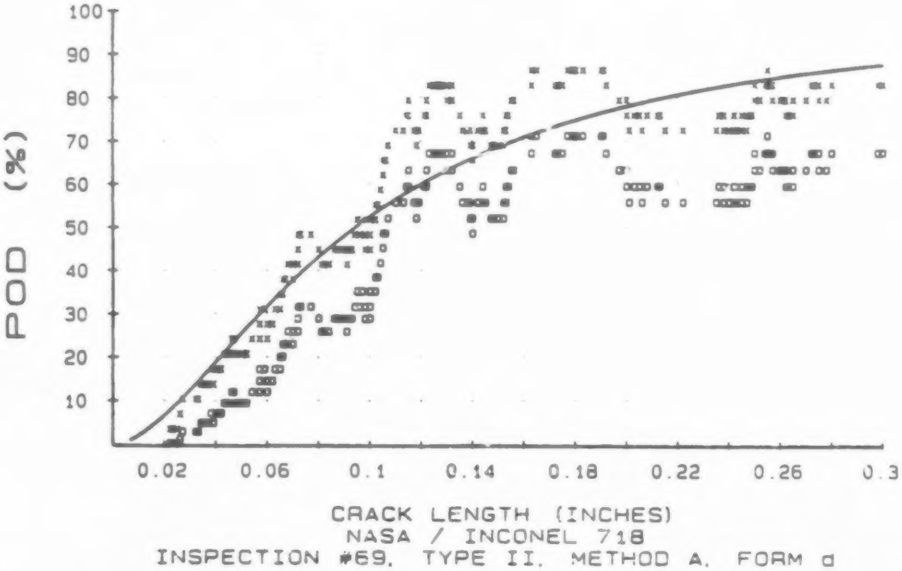


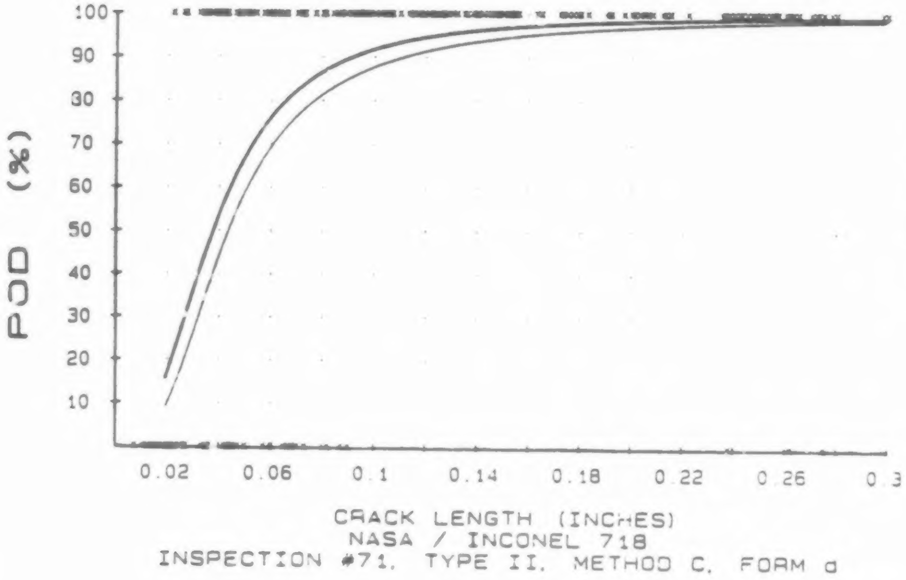
Inspection #69
Inconel 718
110 Specimens
281 Cracks
56.6% Detected
0 False Calls

Maximum Likelihood Analysis



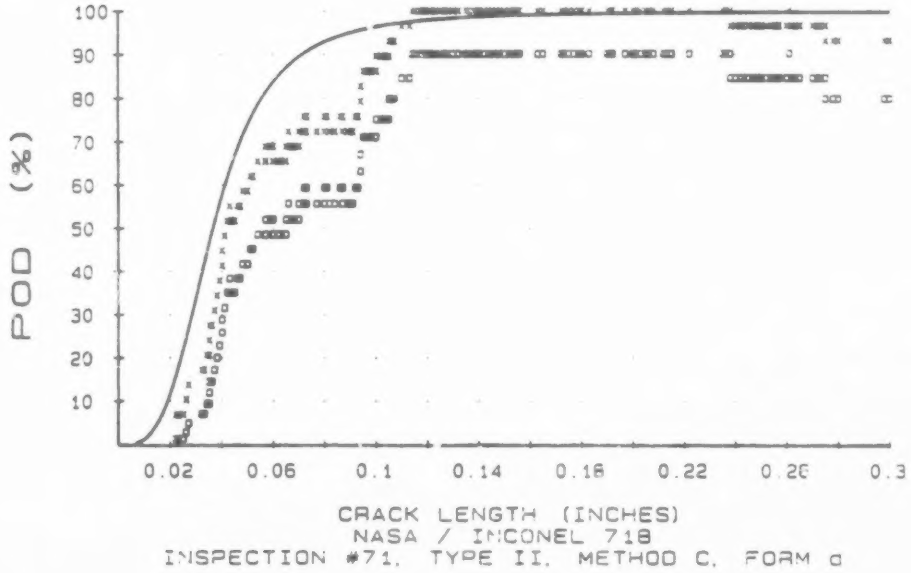
Moving Average Analysis

Figure 5-40
POD Curves for Inspection #69 Performed with Type II, Method A Penetrant



Inspection #71
Inconel 718
110 Specimens
281 Cracks
79.4% Detected
1 False Call

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-41
POD Curves for Best Individual Performance for Inspection Performed with Type II, Method C Penetrant

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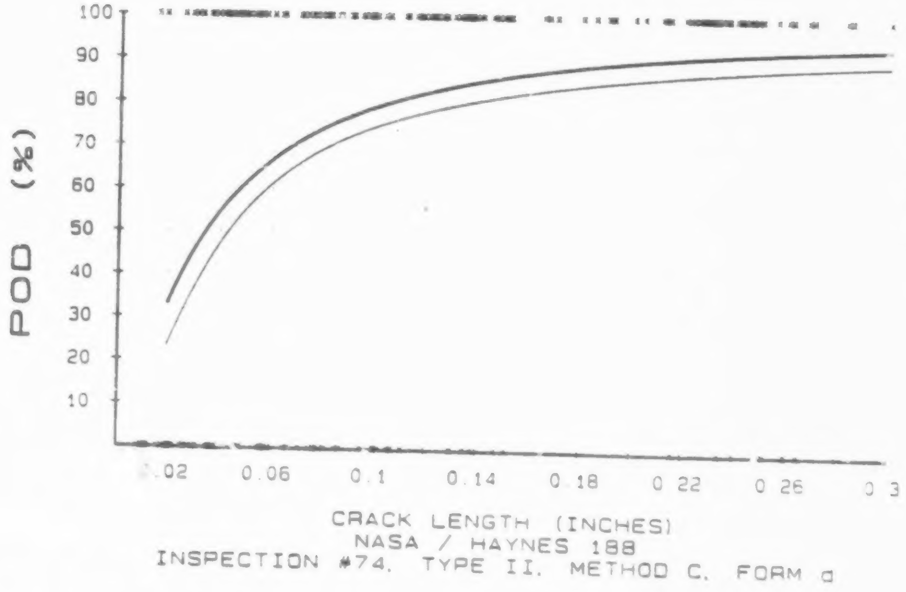
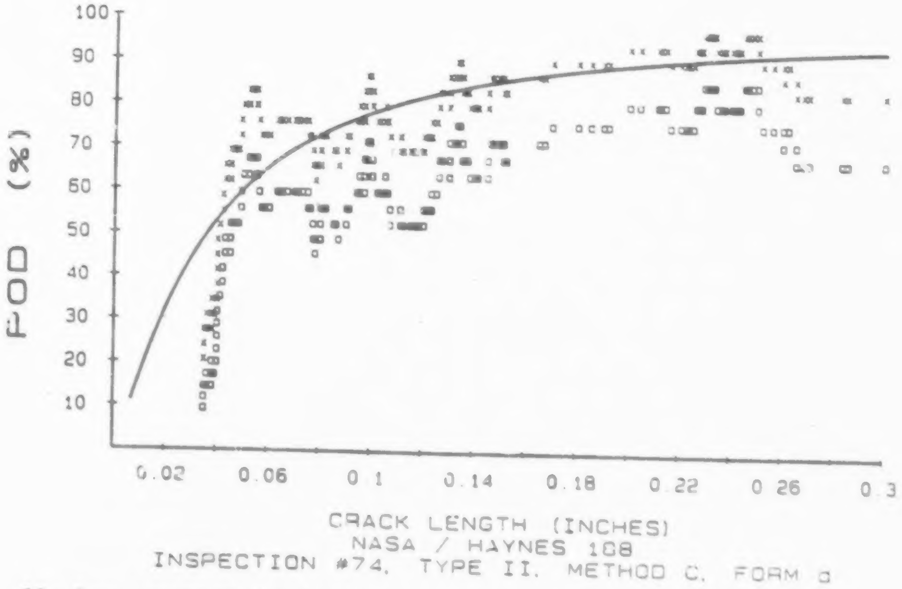


Inspection #74
Haynes 188
102 Specimens
284 Cracks
74.6% Detected
2 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-42
POD Curves for Worst Individual Performance for Inspection Performed with Type II, Method C Penetrant

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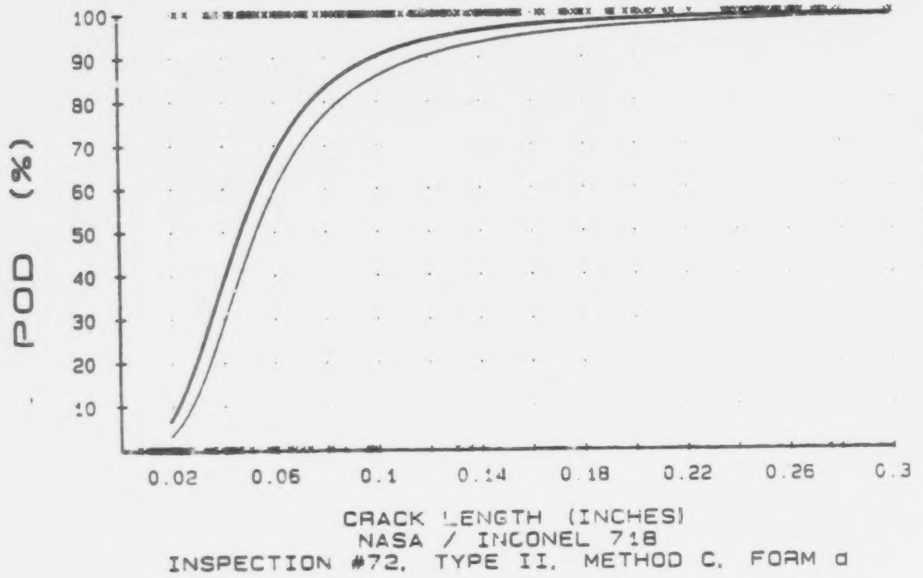
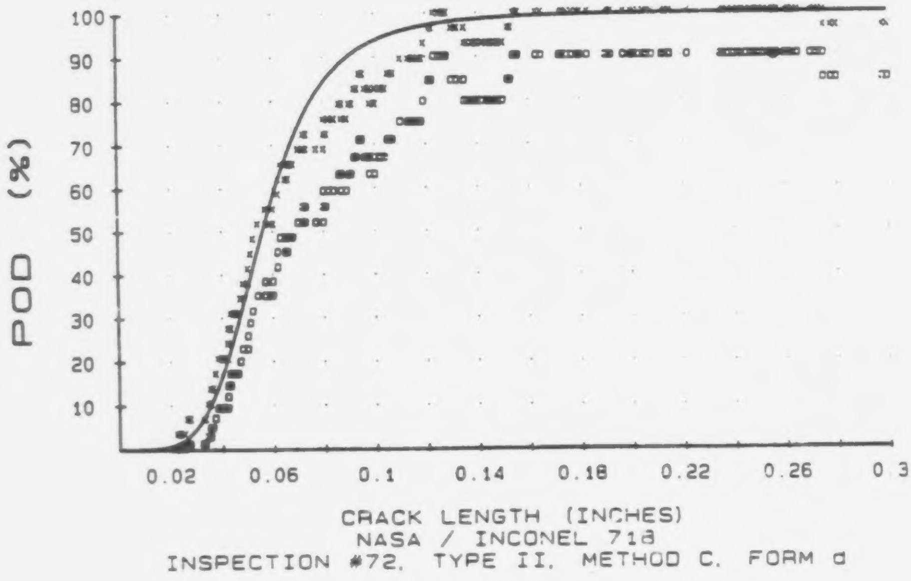


Inspection #72
Haynes 188
102 Specimens
284 Cracks
75.8% Detected
5 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-43
POD Curves for Median Individual Performance for Inspection Performed with Type II, Method C Penetrant

C-2

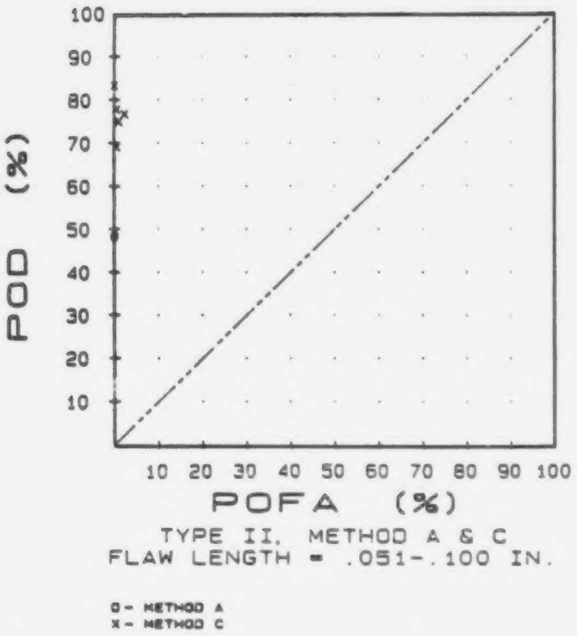


Figure 5-44
Modified ROC Analysis for Inspections Performed with Type II Penetrant (0.051-0.100 in. Flaw Length Range)

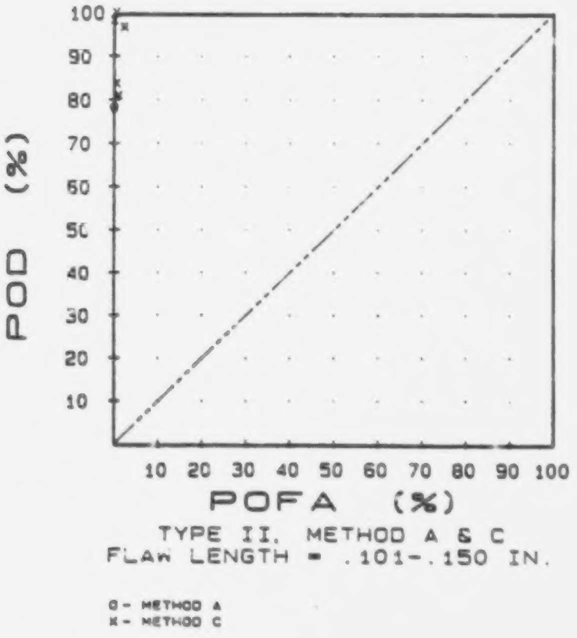


Figure 5-45
Modified ROC Analysis for Inspections Performed with Type II Penetrant (0.101-0.150 in. Flaw Length Range)

All of the inspectors carefully followed the processing parameters specified by the process document and made ample use of inspection aids such as magnifiers, bleed-back techniques and additional developer. As with the fluorescent solvent removable inspections, the greatest processing variable was the amount of solvent used in removing the excess penetrant. The inspectors perfoming Inspection #73 and #74 tended to use excessive remover resulting in over-washing and the flaw detection performance for these 2 inspection was reduced.

The Type II penetrant inspections produced very low false call rates ranging from 0% to 2.3%, well below the average false call rates for the fluorescent penetrant inspections. The false call and flaw detection results from all of the Type II inspections are summarized in Table 5-12.

5.1.6 Type III, Method A Penetrant Inspections

Four Type III, dual mode penetrant inspections were completed during the NDI reliability assessment program. Three of the inspections (Inspections #75, #76, and #78) were completed in the high-sensitivity mode under blacklight and one inspection (Inspection #77) was completed in the low-sensitivity mode under white light. The dual mode inspections are listed in Table 5-13.

Table 5-13
Dual Mode (Type III) Penetrant Process Inspection Sequences

Insp. No.	Inspector Number	Test Set	Penetrant Type	Method	Developer	Sensitivity Mode
75	54	Haynes 188	II	A	Dual Mode	High
76	15	H188 Sbst A	II	A	Dual Mode	High
77	55	H188 Sbst B	II	A	Dual Mode	Low
78	55	H188 Sbst B	II	A	Dual Mode	High

The dual mode method uses red-visible penetrant and a fluorescent developer to provide the two sensitivity levels. The low-sensitivity mode inspection is performed under white light looking for red flaw indictions in the white background provided by the developer. In the low-sensitivity mode, the Type III method is equivalent to Type II inspections. In the high-sensitivity mode the inspections are performed under blacklight causing the developer to fluoresce. In this mode the presence of penetrant kills the fluorescence of the developer leaving jet-black indications in the fluorescent green background provided by the developer.

Processing for the Type III, dual mode inspections was performed by hand by three different operators. Each operator processed 8 specimens at a time. Penetrant application was by brush, and dwell times ranged from 10 to 45 min. For Inspections #75 and #76 the excess penetrant was washed from the part surfaces using a course water spray at 35 to 40 psi and a water temperature of 75 deg. F. The inspectors removed the specimens from the racks and washed them individually, placing them in a clean rack as each panel was completed. The cleaned specimens were allowed to dry in a circulating air oven at a temperature of 140 deg. F until dry (approximately 10 min.). The excess penetrant was removed during Inspections #77 and #78 by wiping with a dry cloth to remove the majority of the penetrant and then wiping with a water moistened cloth to remove the remaining penetrant. Following wiping, the specimens were allowed to air dry. The dual mode (reversible) developer was applied by aerosol can or air brush for the dual mode inspections. All inspectors allowed a minimum of 10 min. for the flaw indications to develop prior to beginning the inspection.

During Inspections #75 and #76, the inspectors first inspected the panels using a hand held blacklight under full shop light conditions. They then took the panels into a dark penetrant inspection booth and reinspected them to determine if any additional indications became visible in the dark background conditions. The inspectors did not detect any additional flaw indications as a result of moving into the dark booth. The method was equally effective in detecting cracks in the high-sensitivity mode whether the inspections were performed in a darkened booth or in full shop light conditions.

The POD curves for the high-sensitivity dual mode inspections are shown in Figures 5-46 through 5-48 and the low sensitivity curve is shown in Figure 5-49. Three of the four dual mode inspections were performed on test specimen subsets. For the subset inspections the POD curves have been plotted using the maximum likelihood method only due to the limited amount of data available. The results from the dual mode inspections are summarized in Table 5-14. Modified ROC diagrams showing the performance of the dual mode process for both sensitivity levels are shown in Figures 5-50 and 5-51 for the 0.051-0.100 in. and 0.101-0.150 in. flaw length ranges.

Table 5-14
Summary of Type III, Dual Mode Penetrant Inspection Results

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050	.051-.100	.101-.150	.151-.250
75	81.3	4.9	56.9%(46.0%)	85.3%(76.3%)	85.3%(76.3%)	96.7%(89.9%)
76	91.7	2.2	82.4%(-----)	91.7%(-----)	92.9%(-----)	100.0%(-----)
77*	82.3	4.8	57.1%(-----)	83.3%(-----)	87.5%(-----)	100.0%(-----)
78	98.4	14.3	92.9%(-----)	100.0%(-----)	100.0%(-----)	100.0%(-----)

* *Low-sensititvity inspection performed in white light as Type II inspection. The remaining inspections were performed under blacklight in the high-sensitivity mode.*

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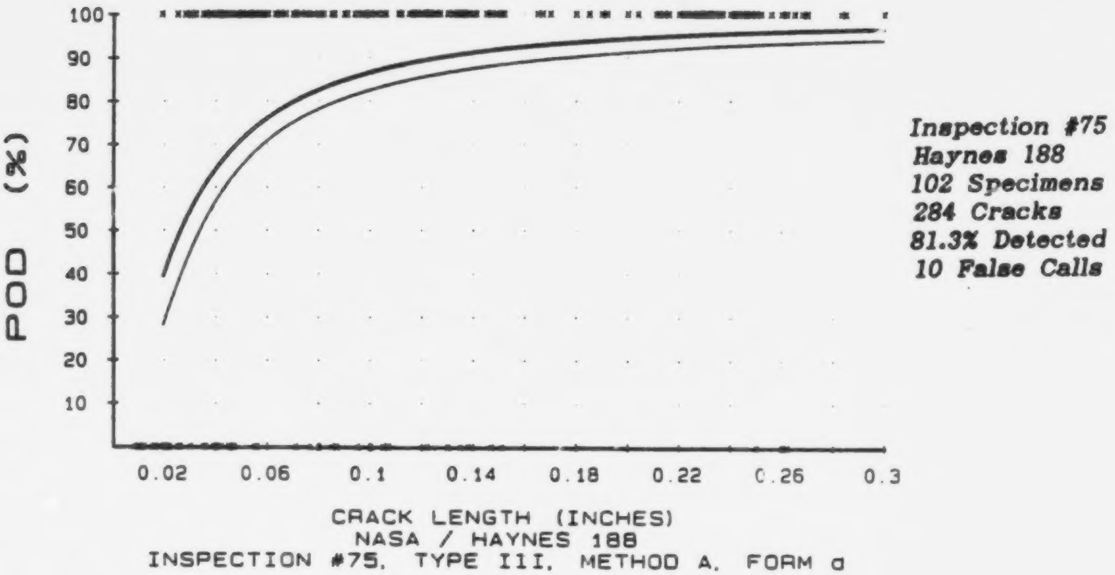
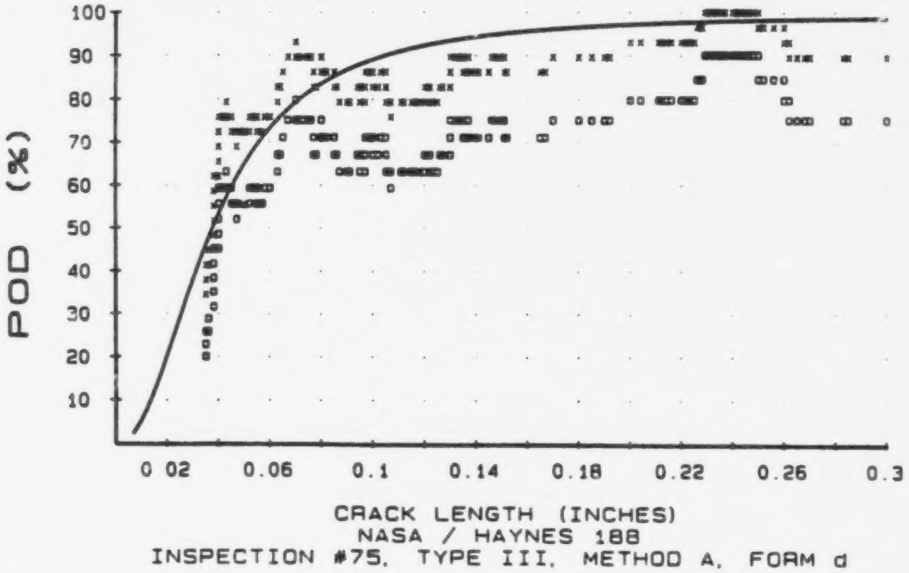


Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-46
POD Curves for Inspection #75 Performed with Type III, Dual Mode Penetrant in the High-Sensitivity Mode

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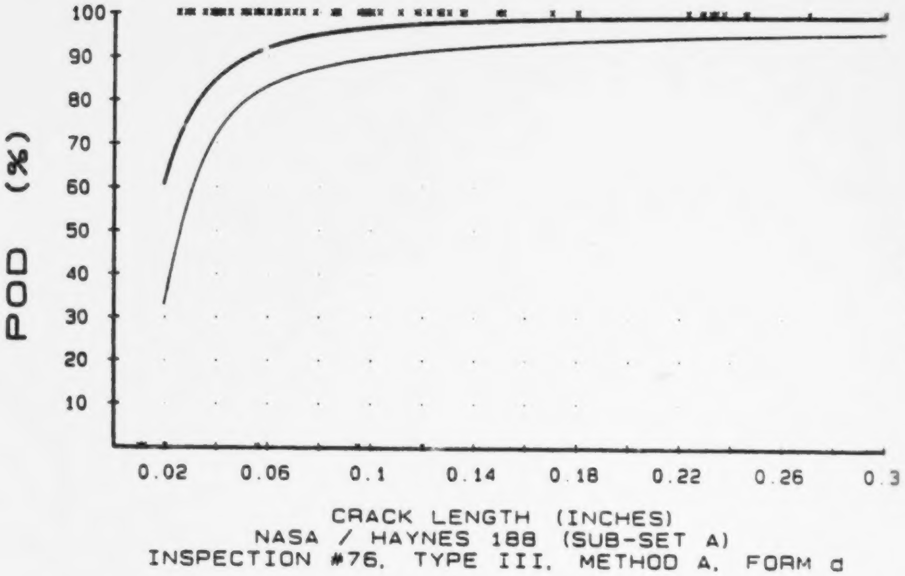
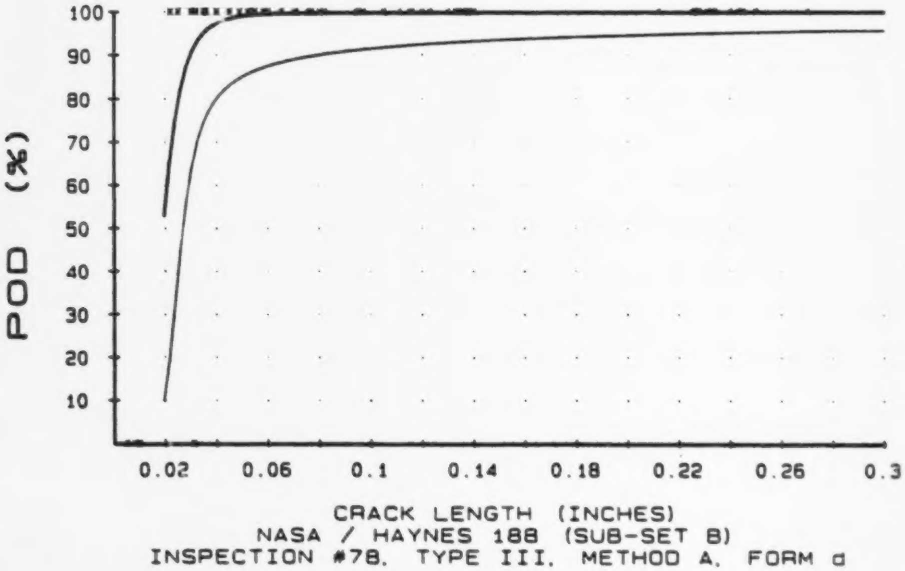


Inspection #76
H188 Subset A
20 Specimens
72 Cracks
91.7% Detected
1 False Call

Maximum Likelihood Analysis

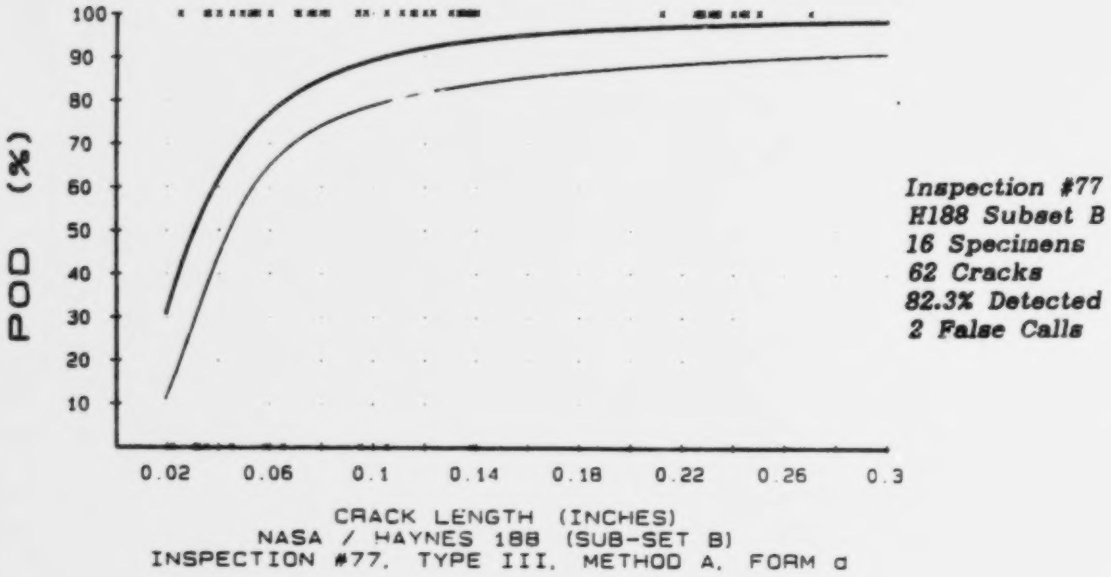
Figure 5-47
POD Curve for Inspection #76 Performed with Type III, Dual Mode Penetrant in the High-Sensitivity Mode



Inspection #78
H188 Subset B
16 Specimens
62 Cracks
98.4% Detected
7 False Calls

Maximum Likelihood Analysis

Figure 5-48
POD Curve for Inspection #78 Performed with Type III, Dual Mode Penetrant in the High-Sensitivity Mode



Maximum Likelihood Analysis

Figure 5-49
POD Curve for Inspection #77 Performed with Type III, Dual Mode Penetrant in the Low-Sensitivity Mode

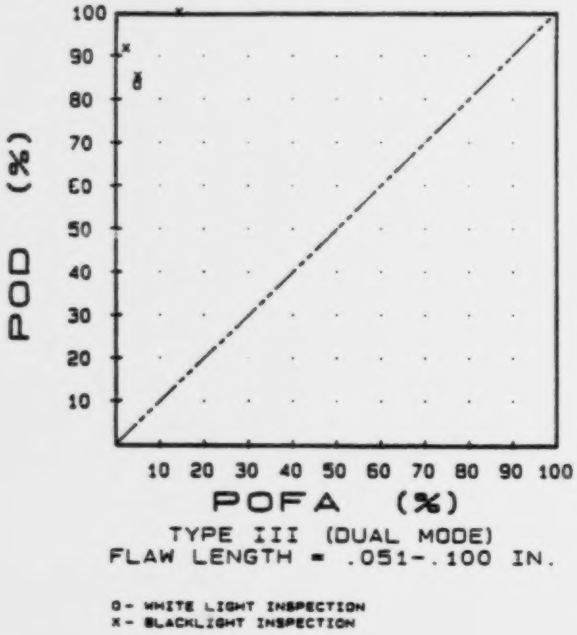


Figure 5-50
Modified ROC Analysis for Inspections Performed with Type III, Dual Mode Penetrant (0.051-0.100 in. Flaw Length Range)

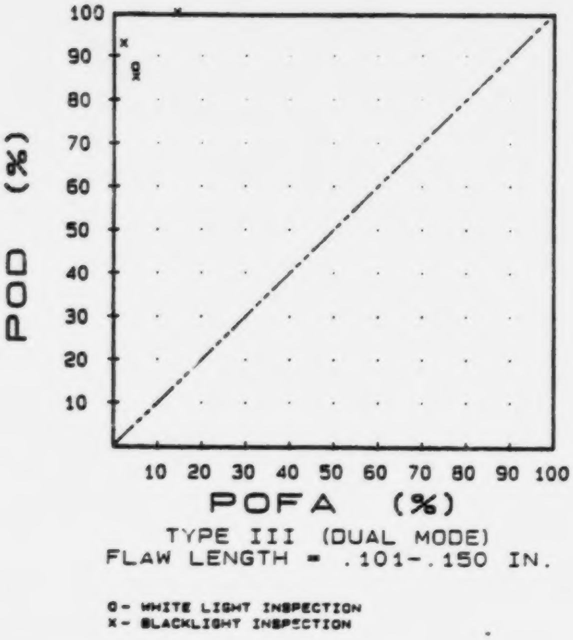


Figure 5-51
Modified ROC Analysis for Inspections Performed with Type III, Dual Mode Penetrant (0.101-0.150 in. Flaw Length Range)

The Type III, dual mode inspection sequences demonstrated detection capabilities equal to that provided by the higher sensitivity level, Type I fluorescent penetrant inspection processes. Two of the inspections were performed in full shop light conditions using a hand-held blacklight. Reexamination of the specimens in a darkened penetrant booth did not reveal any additional flaw indications. This independence from the background white light conditions makes the dual mode process a valuable tool for applications where high sensitivity is required, but the hardware being inspected cannot be conveniently darkened.

5.2 EDDY CURRENT INSPECTION ASSESSMENT RESULTS

Four eddy current inspection sequences were completed during the NDI reliability assessment program. Three of the inspections were performed by hand scanning. The fourth inspection was performed using a computer controlled eddy current scanning bridge.

5.2.1 Principles of Eddy Current Inspection

Eddy current inspection is based on the principles of electromagnetic induction. An inspection is performed through the generation of an eddy current field in a part by placing it adjacent to an electrical coil (probe) in which an alternating current is flowing. The eddy currents flow in closed loops within the part and their magnitude and phase depend on (1) the properties and design of the coil, (2) the electric current used to excite the coil, (3) the electrical properties of the part being inspected, and (4) the electromagnetic fields generated by the eddy currents flowing within the part. The flow of the eddy current field within the part will be disrupted by the presence of cracks or other discontinuities causing a significant change in the associated electromagnetic field. Such disruptions in the electromagnetic field can be detected by monitoring the electrical characteristics of the exciting coil such as its electrical impedance, induced voltage or induced currents.

The size and direction of the generated eddy current field with respect to a defect has a significant impact on the detection capabilities of the inspection. A large eddy current field will only be mildly disrupted by the presence of a small defect while a small field will be significantly altered by the same size flaw. Likewise, the eddy current field will not be greatly disturbed by a crack running parallel to the direction of eddy current flow and will not be as easily detected as one running perpendicular to the current flow.

The shape and size of the induced eddy current field in a part is determined by the size and properties of the coil, the frequency of the alternating current used to excite the coil, and the electrical and magnetic properties of the material being inspected. The surface area of the part covered by the eddy current field is determined largely by the size of the exciting coil. The depth of penetration of the eddy current field is dependent on the frequency of the exciting current and the conductivity of the material being inspected. Increasing the frequency or the material conductivity reduces the depth of the field penetration and the size of the overall field. All of these factors must be considered in selecting the operating parameters for an eddy current inspection and play a part in determining the detection capabilities of the inspection process.

5.2.2 Hand Scan Eddy Current Inspections

Three hand scan eddy current inspection sequences (Inspections #79-#81) were completed using the Haynes 188 test set. All three were performed using portable impedence plane presentation eddy current instruments with no signal filtering. Calibration for Inspection #79 was performed using a 0.042 x 0.010 in. EDM slot in 6Al-4V titanium. Conductivity of the titanium standard and the Haynes 188 specimens were found to be similar enough to produce identical signal amplitudes when scanning the EDM slot after nulling the instrument with the probe placed on either the titanium or on a Haynes 188 specimen. Calibration set-ups for Inspections #80 and #81 were performed using a 0.080 in. long fatigue crack selected from the test set. A second point calibration check was made occasionally during Inspections #80 and #81 using a 0.111 in. fatigue crack.

The operating parameters for the three hand scan inspections are listed in Table 5-15.

Table 5-15
Hand Scan Eddy Current Inspection Operating Parameters

	Insp. #79	Insp. #80	Insp. #81
Operating Frequency	1 MHz	500 kHz	1 MHz
Probe Type	Differential	Differential	Differential
Probe Diameter	0.125 in.	0.750 in.	0.250 in.
Calibration Defect	0.042" EDM	0.080" Crack	0.080" Crack
Cal. Signal:Noise	3:1	2.5:1	2.5:1
Gain	57.5 dB	54.0 dB	51.5 dB
Filtering	None	None	None
Depth of Pen. (est.)	0.022 in.	0.030 in.	0.022 in.

For Inspections #79 and #80, the specimens and calibration defects were presented to the operators for inspection without providing any guidance on probe selection or operating parameters. The inspection personnel were given the freedom to select the probe and operating frequency of their choice and to determine the gain setting and corresponding signal to noise ratio that they felt would provide a reliable inspection. In order to provide a comparison of the performance at two frequencies, the operator performing Inspection #81 was instructed to perform the inspection at 1 MHz and maintain the 2.5:1 signal to noise ratio used for calibration during inspection #80.

Teflon tape was used on the probe contact surface for all three inspections to maintain consistent probe lift-off, ease scanning, and reduce probe wear. The phase angle was adjusted to align lift-off in the horizontal direction. The test specimens were hand scanned using a plastic ruler as a scanning guide for Inspection #79. A specimen holder with indexing probe guide was used to aid scanning during Inspections #80 and #81. Scanning for all three eddy current inspection sequences was started with the edge of the probe flush with one edge of the specimen and then indexed in 0.125 in. increments until the probe was flush with the opposite edge of the specimen as shown in Figure 5-52.

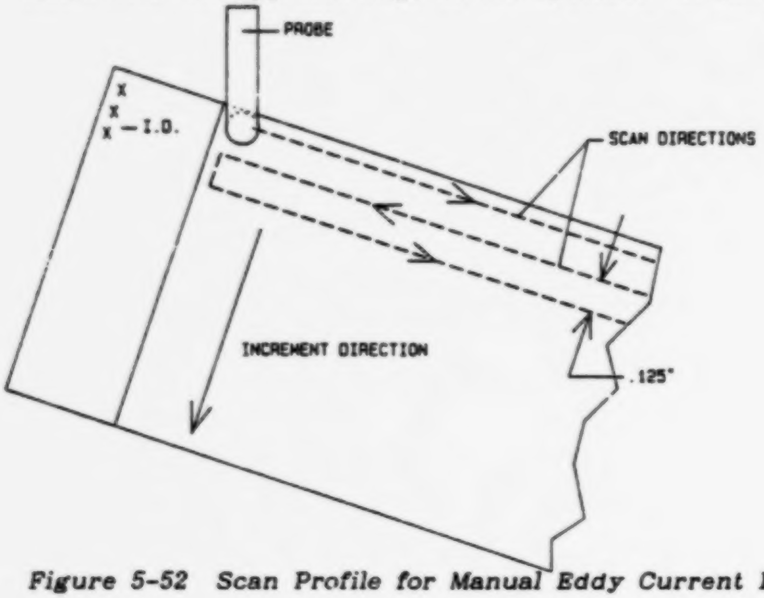


Figure 5-52 Scan Profile for Manual Eddy Current Inspections

The POD curves for the hand scan eddy current inspection sequences are shown in Figures 5-53 through 5-55. Because eddy current signal amplitudes are highly dependent on flaw depth as well as flaw length, POD curves have also been plotted for the eddy current inspections as a function of flaw depth and are shown in Figures 5-56 through 5-58. The results for the eddy current inspection sequences have been summarized in Table 5-16. Modified ROC curves for the three hand scan eddy current inspections are shown in Figures 5-59 and 5-60 for the 0.051 to 0.100 in. and 0.101 to 0.150 in. crack length ranges.

Table 5-16
Summary of Eddy Current Inspection Sequence Results

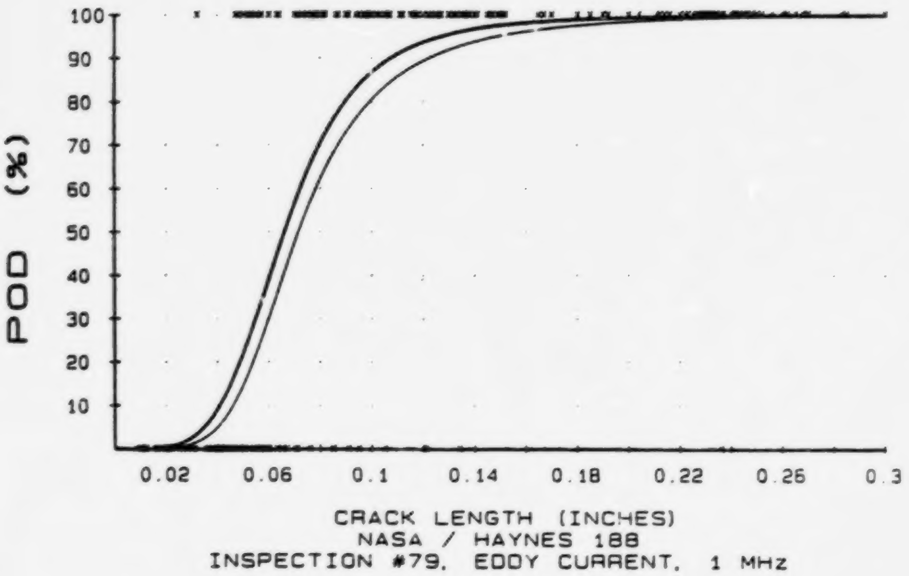
Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
79	68.0	2.9	6.2%(2.1%)	66.2%(55.6%)	95.6%(89.0%)	98.3%(92.4%)
80	60.2	4.9	1.5%(0.8%)	42.6%(32.5%)	94.1%(87.0%)	100.0%(95.1%)
81	70.1	4.9	9.2%(4.1%)	73.5%(63.3%)	97.1%(91.0%)	98.3%(92.4%)
82	62.7	6.9	0.0%(0.0%)	42.6%(32.5%)	98.3%(93.2%)	100.0%(95.1%)
Ave.	65.2	4.9	4.2%(1.8%)	56.2%(46.0%)	96.3%(90.0%)	99.1%(93.8%)

The two inspections performed at 1 MHz (Inspections #79 and #81) produced very similar results. The inspectors made careful use of the scanning aids to insure 100% part coverage and rescanned all areas that showed a flaw indication to maximize the signal obtained. Inspection #79 was performed using a 0.125 in. dia probe and Inspection #81 was performed using a 0.250 in. dia probe, yet, both inspectors used a 0.125 in. scan line increment. Using a scan line increment equal to the probe diameter for Inspection #79 resulted in no overlap of probe coverage and may explain the slightly lower results obtained even though a smaller diameter probe was used.

The detection capabilities demonstrated at 500 kHz (Inspection #80) were less than those obtained at 1 MHz, particularly for flaws less than 0.100 in. long. Even though the calibration procedures for Inspections #80 and #81 were the same, the large eddy current field produced by the large diameter probe (0.750 in.) and the lower operating frequency resulted in less sensitivity to small defects. The use of a probe with a diameter significantly larger than the size of the flaws requiring detection limited the detection capabilities of this inspection.

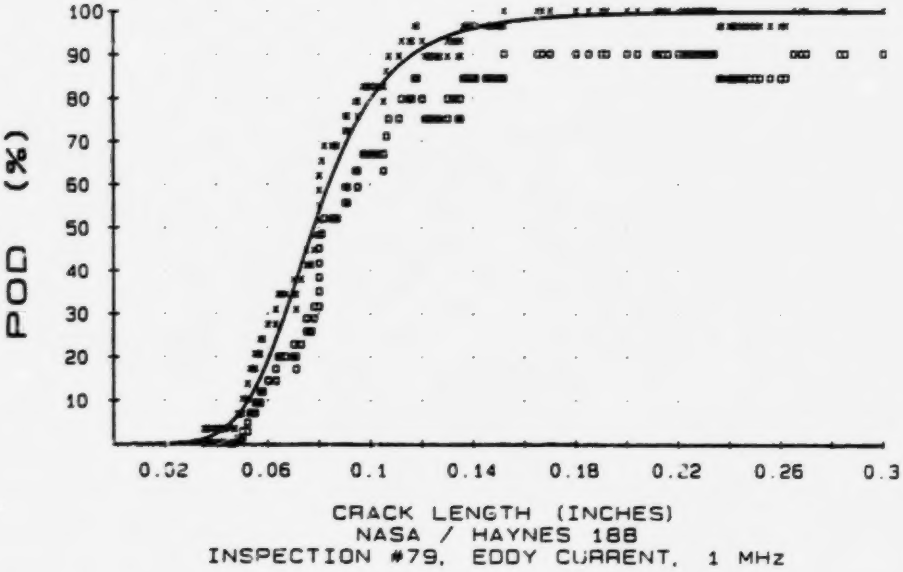
5.2.3 Automated Scan Eddy Current Inspection

The Haynes 188 test specimens were used to assess the flaw detection capabilities of an automated scan eddy current inspection procedure. The eddy current inspection system consisted of a high precision computer controlled X/Y scanning bridge, an impedance plane presentation eddy current instrument with filtering capability, and a strip chart recorder. This inspection (Inspection #82) was performed using a 1 MHz, .125" dia shielded absolute probe. Teflon tape (0.003" thick) was used between the probe and test panels to provide for a constant lift-off.



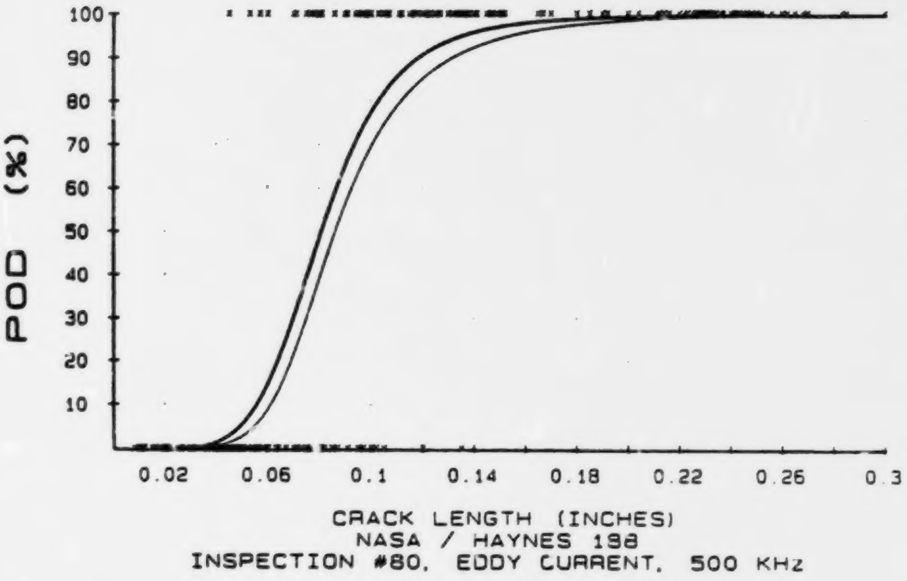
Inspection #79
Haynes 188
102 Specimens
284 Cracks
68.0% Detected
3 False Calls

Maximum Likelihood Analysis



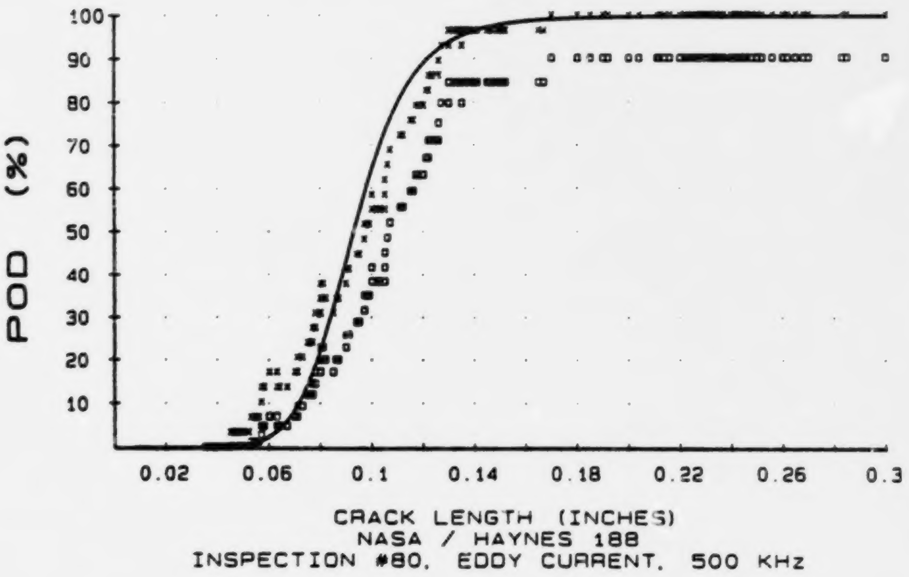
Moving Average Analysis

Figure 5-53
POD Curves Plotted by Crack Length for Inspection #79, 1 MHz Manual Eddy Current Inspection Using a 0.125 in. dia Differential Probe



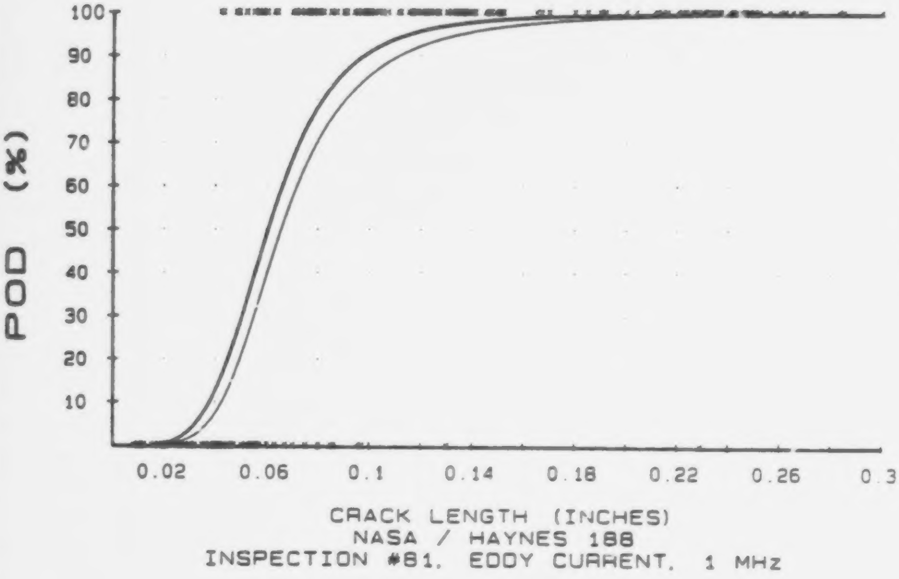
Inspection #80
Haynes 188
102 Specimens
284 Cracks
60.2% Detected
5 False Calls

Maximum Likelihood Analysis



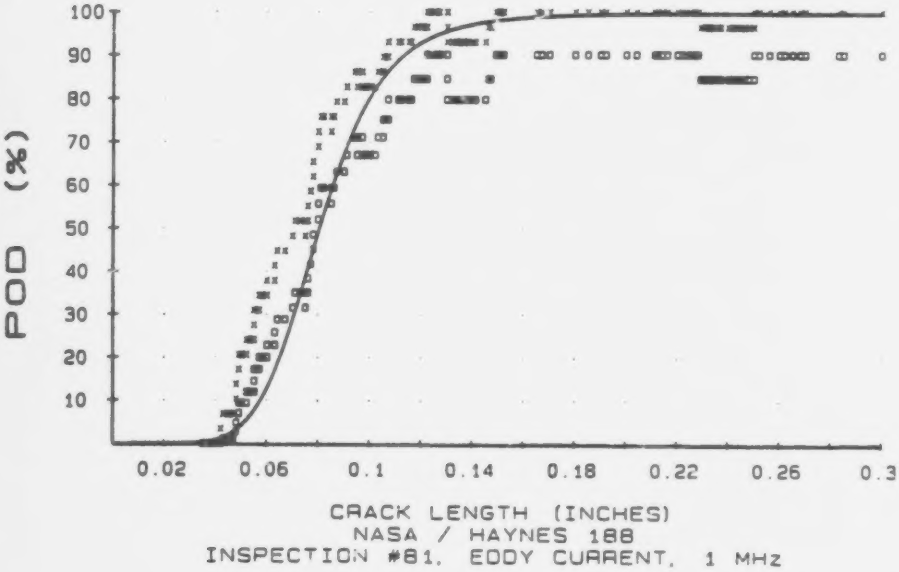
Moving Average Analysis

Figure 5-54
POD Curves Plotted by Crack Length for Inspection #80, 500 KHz Manual Eddy Current Inspection Using a 0.750 in. dia Differential Probe



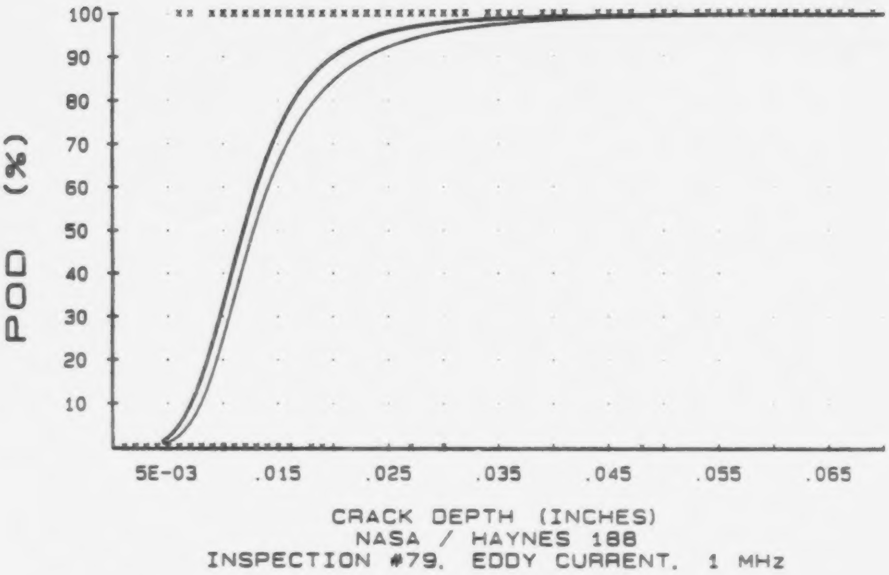
Inspection #81
Haynes 188
102 Specimens
284 Cracks
70.1% Detected
5 False Calls

Maximum Likelihood Analysis



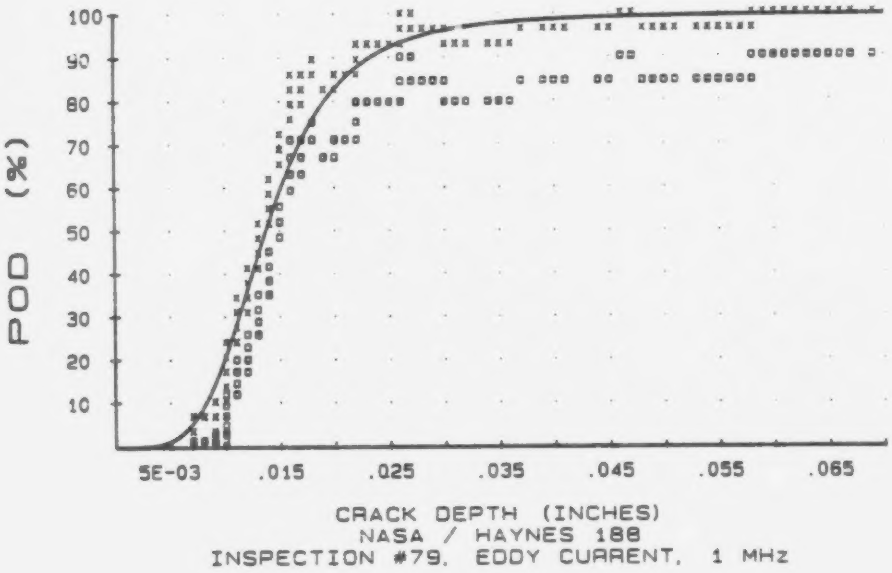
Moving Average Analysis

Figure 5-55
POD Curves Plotted by Crack Length for Inspection #81, 1 MHz Manual Eddy Current Inspection Using a 0.250 in. dia Differential Probe



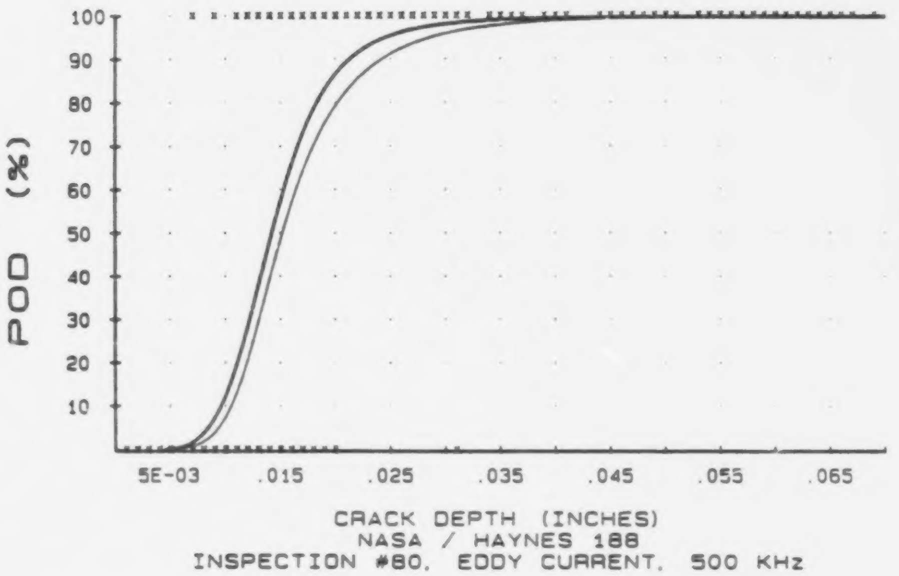
Inspection #79
Haynes 188
102 Specimens
284 Cracks
68.0% Detected
3 False Calls

Maximum Likelihood Analysis



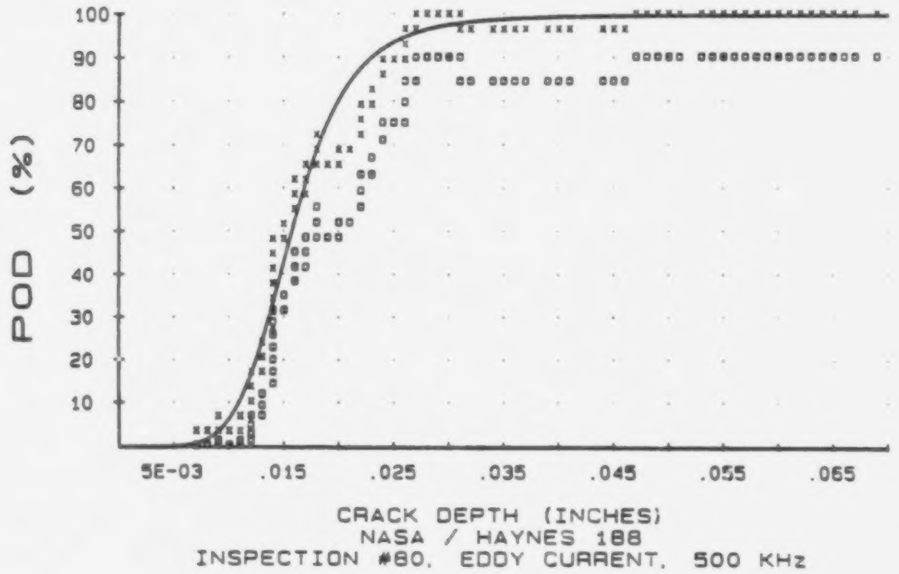
Moving Average Analysis

Figure 5-56
POD Curves Plotted by Crack Depth for Inspection #79, 1 MHz Manual Eddy Current Inspection Using a 0.125 in. dia Differential Probe



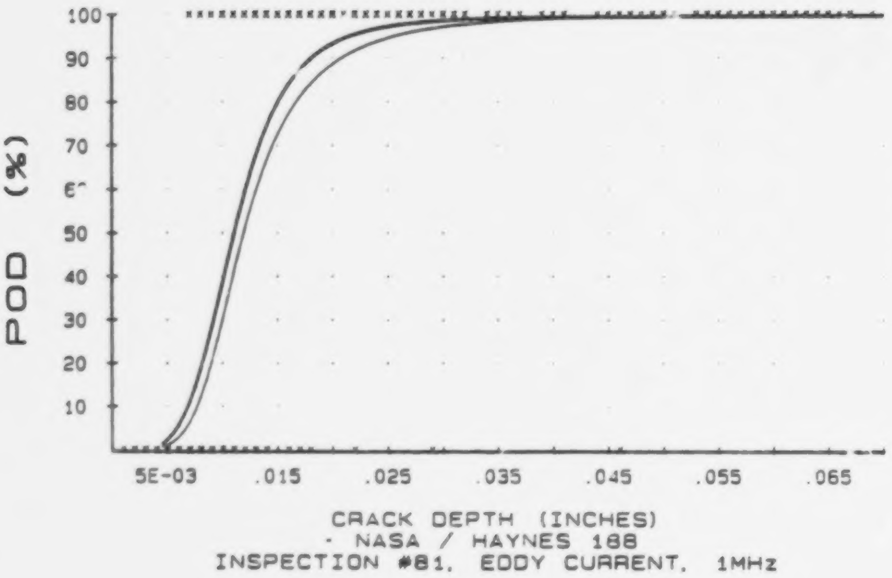
Inspection #80
Haynes 188
102 Specimens
284 Cracks
60.2% Detected
5 False Calls

Maximum Likelihood Analysis



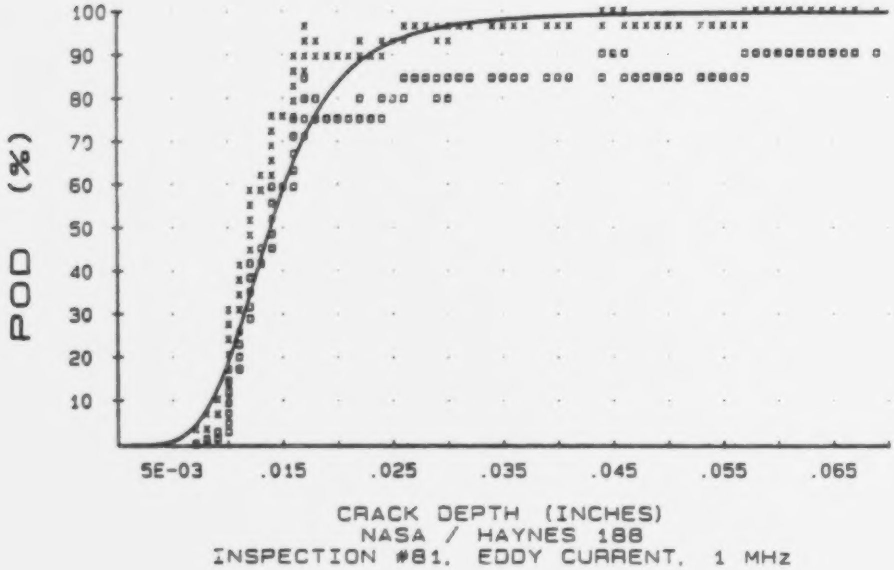
Moving Average Analysis

Figure 5-57
POD Curves Plotted by Crack Depth for Inspection #80, 500 KHz Manual Eddy Current Inspection Using a 0.750 in. dia Differential Probe



Inspection #81
Haynes 188
102 Specimens
284 Cracks
70.1% Detected
5 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-58
POD Curves Plotted by Crack Depth for Inspection #81, 1 MHz Manual Eddy Current Inspection Using a 0.250 in. dia Differential Probe

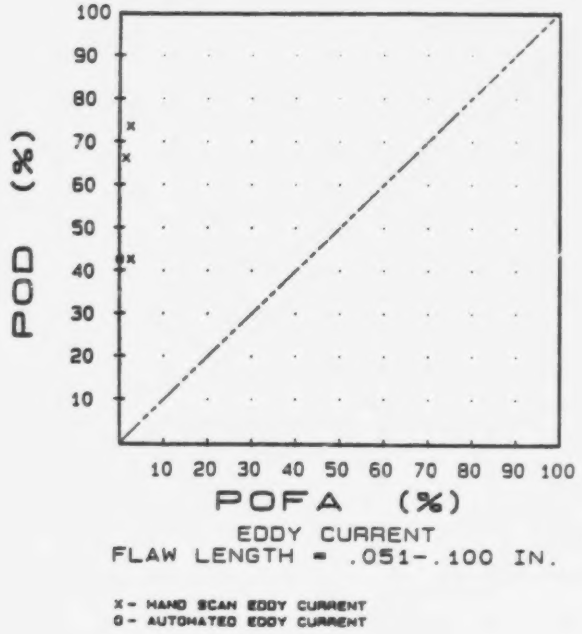


Figure 5-59
Modified ROC Analysis for Manual and Automated Eddy Current Inspections (0.051-0.100 in. Flaw Length Range)

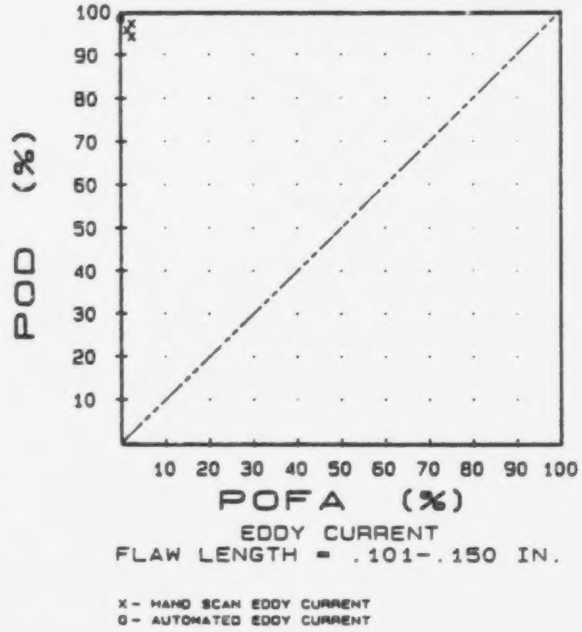


Figure 5-60
Modified ROC Analysis for Manual and Automated Eddy Current Inspections (0.101-0.150 in. Flaw Length Range)

The inspection procedure development and calibration were performed using a 0.080 in. long by 0.010 in. deep fatigue crack selected from the test set. The inspector was instructed to use a 1 MHz operating frequency and a signal to noise ratio of 3:1 for instrument calibration. The inspector evaluated both an absolute probe and a differential probe before selecting the absolute probe for use.

The absolute probe provided a better signal to noise ratio due to a significant reduction in the noise signal obtained when scanning the Haynes 188 specimens.

The instrument filters were set to maximize the signal to noise ratio obtained when scanning the calibration flaw. The gain was then adjusted to produce a 3:1 signal to noise ratio with lift-off in the horizontal direction. The baseline instrument settings used for this inspection were as follows:

Frequency - 1 MHz
Gain - 100
High Pass Filter - 2 Hz
Low Pass Filter - 30 Hz
Phase Angle - 266 deg
Strip Chart Recorder Gain - 100 mV/mm
Chart feed rate - 1.0 mm/s
Est. Depth of Penetration - 0.022 in.

The panels were scanned at a rate of 0.54 in./s parallel to the panel length. The increment between scan lines was 0.045 in. or approximatly 1/3 the probe diameter. The vertical channel output from the eddy current instrument was recorded using the strip chart recorder. The strip chart results were analyzed off-line to record those flaws detected and to obtain a profile of the flaw signal amplitude and background noise distributions. The signal amplitude was recorded for each crack that could be identified on the strip chart recording. The relationship between flaw size and signal amplitude is shown in Figure 5-61. In addition to the flaw signal amplitudes, the largest nonrelevant signal whose cause could not be readily identified was recorded as the noise amplitude for each specimen inspected.

The signal and noise amplitude distribution data was used to plot a threshold diagram showing the relationship between acceptance criteria, POD, and POFA (Figure 5-62). Based on this diagram, an acceptance criterion of 11 divisions was selected as the lowest level that could be used and still maintain a low false call rate for an automated production inspection. The inspection POD curves were then plotted using the 11 division acceptance criterion.

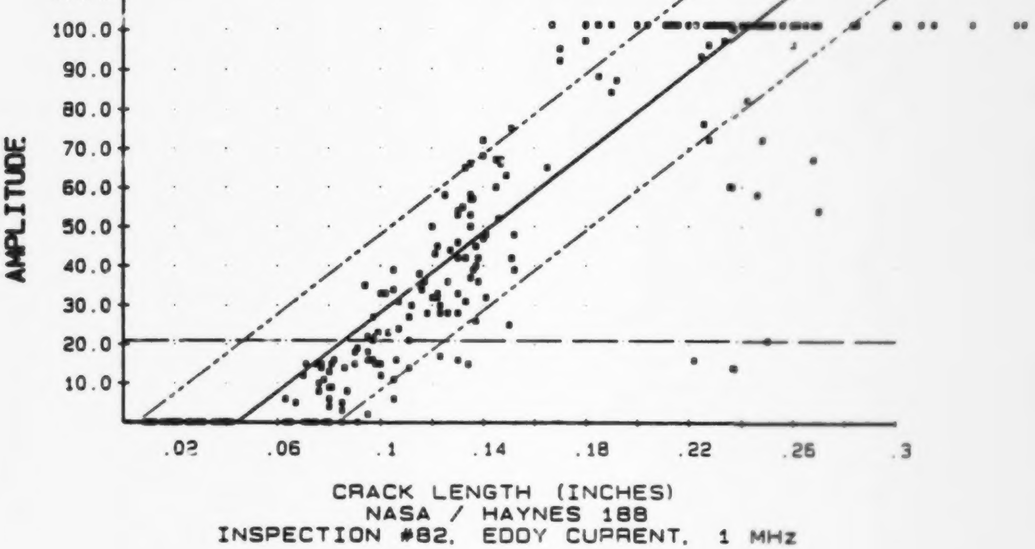


Figure 5-61
Plot of Signal Amplitude as a Function of Crack Length for Automated Eddy Current Inspection (Inspection #82) Using a 0.125 in. dia Absolute Probe

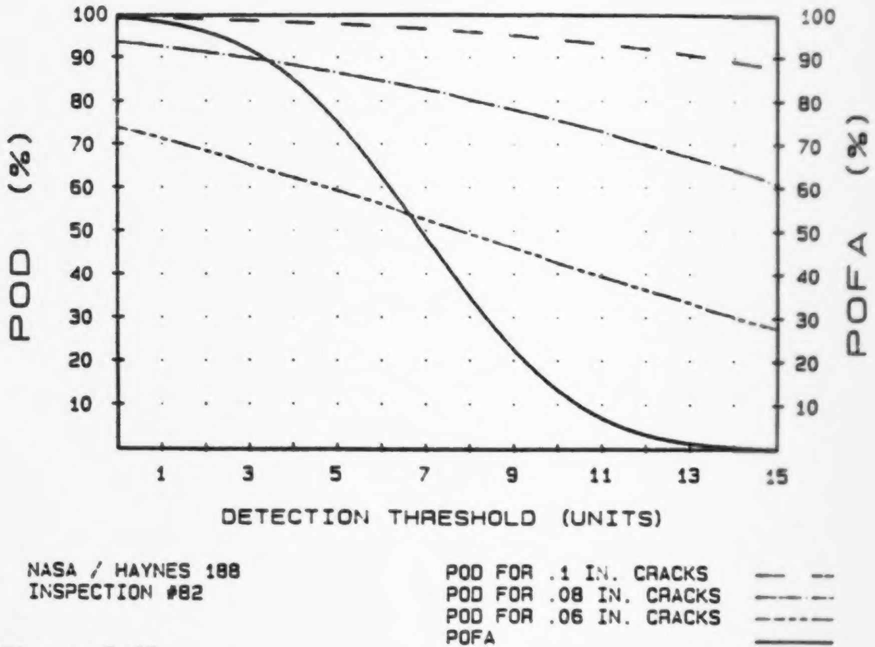


Figure 5-62
Threshold Diagram Showing the Relationship of POD and POFA to Acceptance Criteria for the Automated Scan Eddy Current Inspection

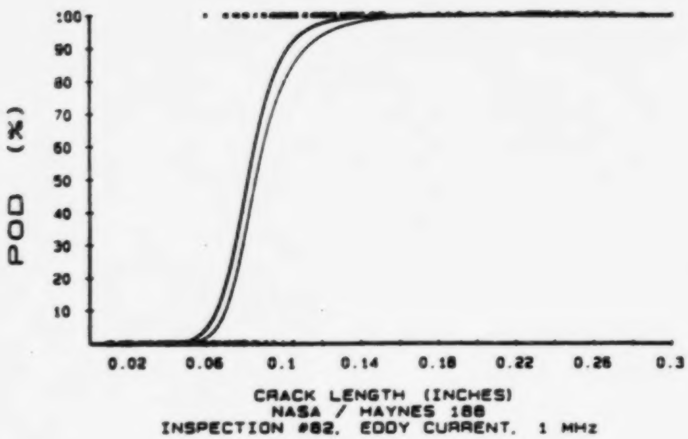
The results from this inspection were analyzed and plotted as POD curves using the moving average, maximum likelihood, and â versus a methods of analysis. Detection was plotted as a function of flaw length and flaw depth by each method. The set of POD curves for this inspection are shown in Figures 5-63 and 5-64. The results from the automated eddy current inspection (Inspection #82) have been summarized with the manual eddy current inspection data in Table 5-16.

Data collection for this eddy current inspection was fully automated. The strip chart recordings of the vertical channel amplitudes were analyzed at the completion of the sequence for flaw identification. As a consequence, all signal pattern recognition that could be gained from the eddy current instrument oscilloscope display was lost in making the flaw/no flaw decisions. The 1 MHz operating frequency was selected to allow comparison's to be made with the hand scan eddy current inspections that were performed at 1 MHz (Inspections #79 and #81). The flaw length at 90% detection on the POD curves for the automated scan eddy current inspection was consistent with the hand scan results.

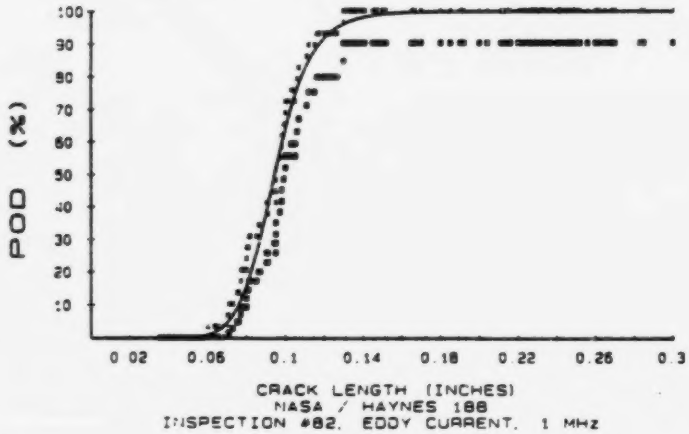
The automated scan inspection however, detected fewer cracks with a length less than 0.100 in. than did the manual inspections. The inspectors performing the manual inspections thoroughly investigated each indication detected by varying probe position and scan speed to maximize the flaw signal amplitude obtained. As a result, they identified the signals from a number of smaller flaws as rejectable indications. During the automated inspection, the scan speed and probe increments remained constant so that those flaws producing signals less than the 11 division acceptance criterion were consistently accepted (not detected). Additional small flaws could be detected by the automated scan eddy current technique by reducing the acceptance criterion below 11 divisions. However this increase in detection would be at the expense of additional false calls caused by noise resulting from the specimen surface finish. The effects of decreasing the acceptance criterion on detection performance is discussed further in section 6.5.2.

The eddy current flaw detection performance demonstrated during this program does not represent the detection limits that are possible with eddy current inspection technology. The inspectors performing the inspections were not given a great deal of time for developing an optimized technique and were in most cases unfamiliar with the Haynes 188 alloy. Additional flaw detection capability could have been achieved through the use of smaller diameter probes, higher operating frequencies, more thorough scan coverage, calibration using a smaller defect and higher signal to noise ratio (higher gain), and by optimizing the apparent phase angle differential between lift-off and flaw signal using the vertical and horizontal channel sensitivity controls. The surface finish of the Haynes 188 specimens (64 RMS) produced a noise level which masked the signals from the smaller defects. Improving the part surface finish would result in better discrimination of the smaller flaws.

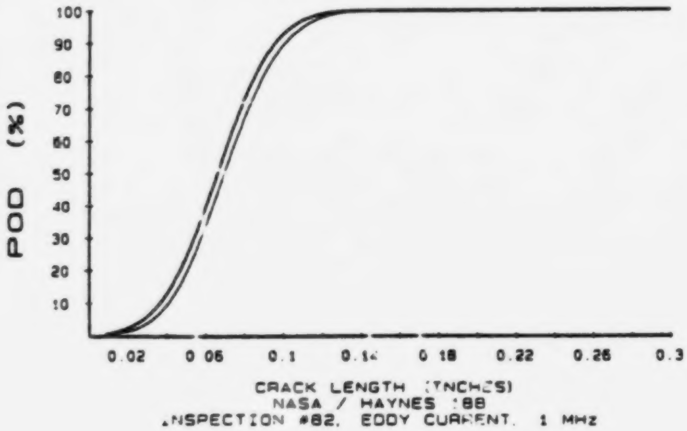
Inspection #82
Haynes 188
102 Specimens
284 Cracks
62.7% Detected
7 False Calls



Maximum Likelihood Analysis

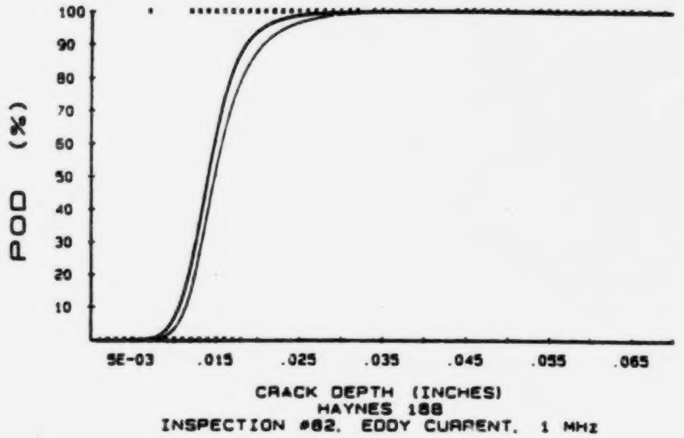


Moving Average Analysis



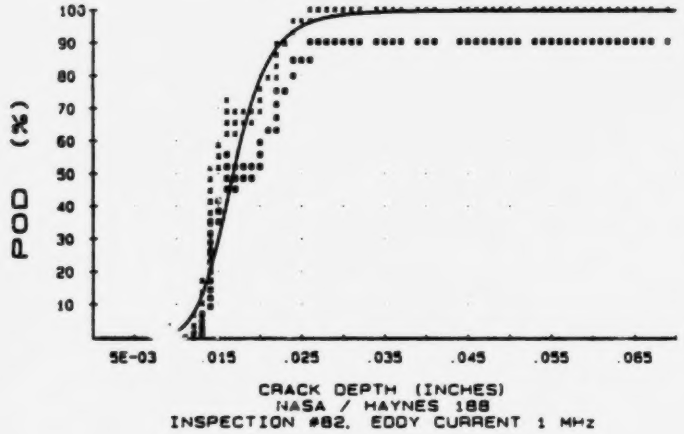
â versus a Analysis

Figure 5-63
POD Curves Plotted by Crack Length for Inspection #82, Automated Eddy Current Inspection (0.125 in. dia Absolute Probe)

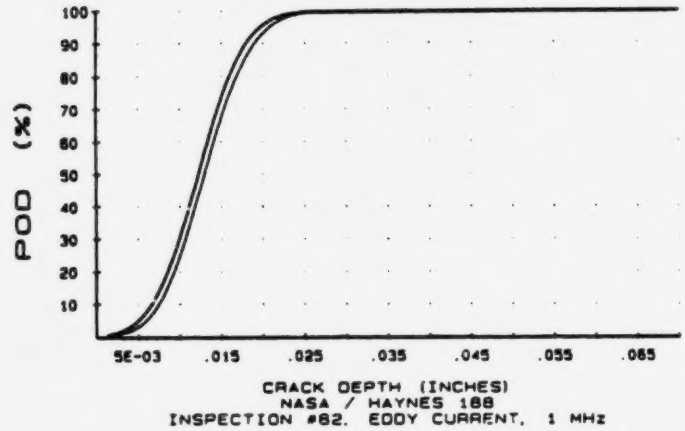


Inspection #82
Haynes 188
102 Specimens
284 Cracks
62.7% Detected
7 False Calls

Maximum Likelihood Analysis



Moving Average Analysis



â versus a Analysis

Figure 5-64
POD Curves Plotted by Crack Depth for Inspection #82, Automated Eddy Current Inspection (0.125 in. dia Absolute Probe)

5.3 ULTRASONIC INSPECTION ASSESSMENT RESULTS

Three ultrasonic inspection sequences were completed using the Inconel 718 test set. One automated scan induced shear wave immersion inspection and two hand scan contact shear wave inspections were performed.

5.3.1 Principles of Ultrasonic Inspection

Ultrasonic pulse-echo inspection is performed by introducing short bursts of ultrasonic energy into the test article at regular intervals of time using an ultrasonic transducer. If the ultrasonic pulses encounter a reflecting surface (boundary), such as a defect, part or all of the energy is reflected. The proportion of energy that is reflected is dependent on the size and orientation of the defect in relation to the ultrasonic beam. Detection of defects is accomplished by monitoring the amount of energy reflected and the time delay between the initial pulse and the receipt of the echo. The direction of the ultrasonic beam in the hardware can be varied depending on the orientation of the anticipated defects. A longitudinal beam which travels perpendicular to the part surface is used to detect internal defects that have a major surface parallel to the part surface such as delaminations. A shear wave enters the part at an acute angle to the hardware surface and is used for the detection of internal and surface defects with orientations other than parallel to the part surfaces. A surface wave travels parallel to the part surface and is used to detect defects that are perpendicular to and extend to the part surface.

Air is a poor transmitter of ultrasonic energy so a coupling medium is required between the transducer and the hardware being interogated to transfer the ultrasonic pulse from the transducer to the hardware. Commonly used couplants include water, oils, glycerin and grease. The coupling material selected and the degree to which it couples the transducer to the test piece effects the amount of energy that is transfered to the hardware.

Information from a pulse-echo inspection is commonly presented in one of three forms: (a) an A-Scan presentation, which is a quantitative display of echo amplitude and time-of-flight data for specific reflectors encountered in the test piece; (b) a B-Scan, which is a quantitative cross-sectional display of time-of-flight data obtained along a plane perpendicular to the surface of the test piece; or (c) a C-Scan, which is a semi-quantitative (gray or color scale) presentation of echo amplitude data obtained over an area of the test piece.

The detection capabilities of an ultrasonic inspection are effected by the frequency (wave length) of the ultrasonic energy, the transducer size and corresponding size of the sound beam, the orientation of the defects with respect to the sound path, the inspection calibration procedures, and the inspection acceptance criteria. The detection of surface related defects is also effected by the amount of energy (noise) that is reflected due to the condition of the hardware surface.

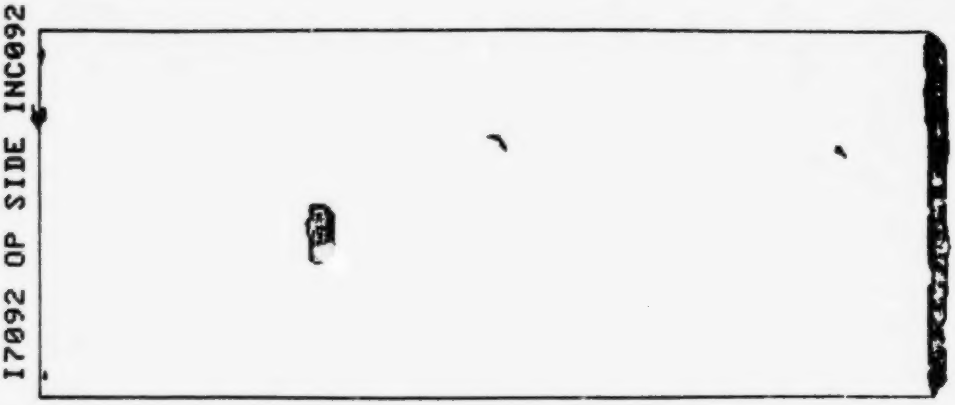
5.3.2 Automated Scan Immersion Inspection

The Inconel 718 test specimens were used to assess the flaw detection capabilities of an immersion ultrasonic shear wave inspection procedure (Inspection #83). A 1/2 in. diameter, 5 MHz transducer was used with an incident angle of 23 deg (55 deg refracted angle). Scanning was performed using a computer controlled X/Y bridge. The panels were scanned at right angles to the flaw orientations with a 0.050 in. increment between scan lines. Data from the automatic scan of the test specimens was sampled and stored in a 0.05 by 0.05 in. grid pattern. The results from the inspections were documented in hard copy using a conventional C-Scan presentation, and using a 45 deg contour presentation to show defect amplitudes by 10% increment contour lines. Examples of the C-Scan and 45 deg contour results from the inspection of an Inconel 718 specimen are shown in Figure 5-65. The amplitude data for each 0.05 by 0.05 in. grid area (pixel) was stored using hard disk for the entire Inconel 718 test set.

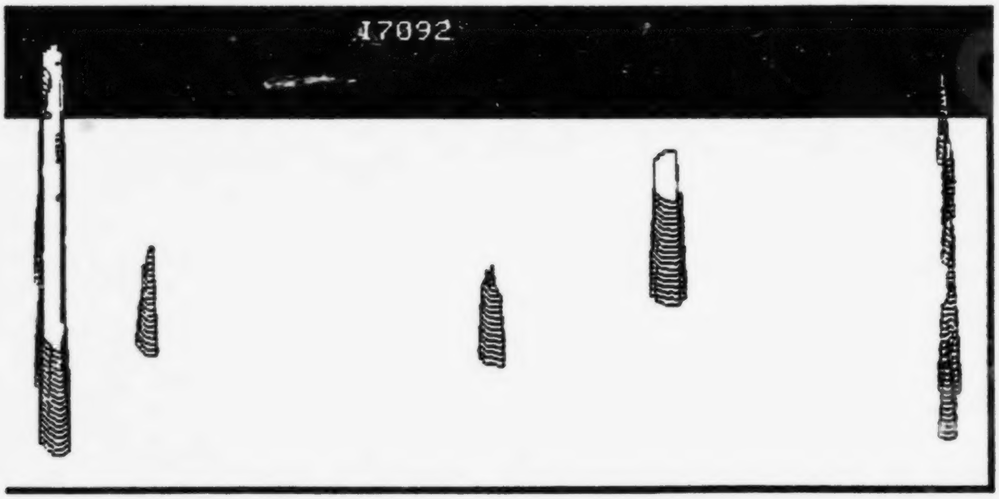
A 0.073 in. long fatigue crack with an estimated depth of 0.010 in. was selected from the test set to use as a standard for calibration. The gain was adjusted to produce a 80% screen height signal using this defect. The acceptance criterion (gate) used for plotting the "C" scans was 60% screen height. The 60% gate was selected based on the noise levels recorded by scanning several specimens selected at random. The recorded noise distribution indicated that an acceptance criterion less than 60% screen height would have resulted in a large number of false calls. All signals exceeding 5% screen height were used to plot the 45 deg contour diagrams. The contour diagrams were used to record the signal amplitude for each flaw inspected. A noise value was recorded from the contour plots for each specimen using the largest nonrelevant signal resulting from the inspection of each panel. The inspection set-up parameters for Inspection #83 are summarized as follows:

Frequency - 5 MHz
Transducer Diameter - 1/2 in.
Incident Angle - 23 deg
Refracted Angle - 55 deg
Couplant - Water (Immersion)
Calibration Defect - 0.073 x 0.010 in. Fatigue Crack
Calibration Amplitude - 80% Screen Height
Acceptance Criterion - 60% Screen Height
Gate (Time Base) - Second Leg

The results from this inspection were plotted as POD curves using the moving average and maximum likelihood methods of analysis. The resulting POD curves are shown in Figure 5-66. These curves were plotted using the 60% screen height acceptance criterion and the results are summarized in Table 5-17.

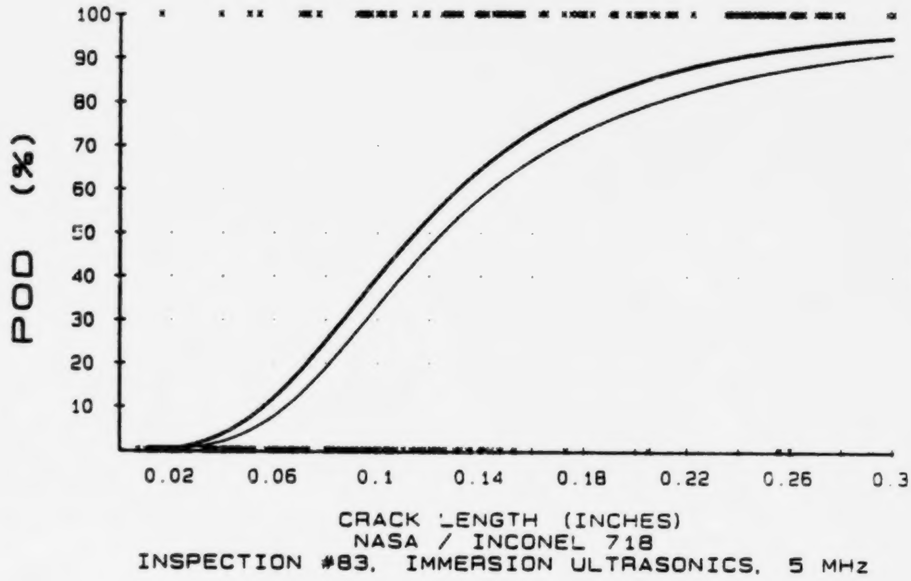


C-Scan Presentation



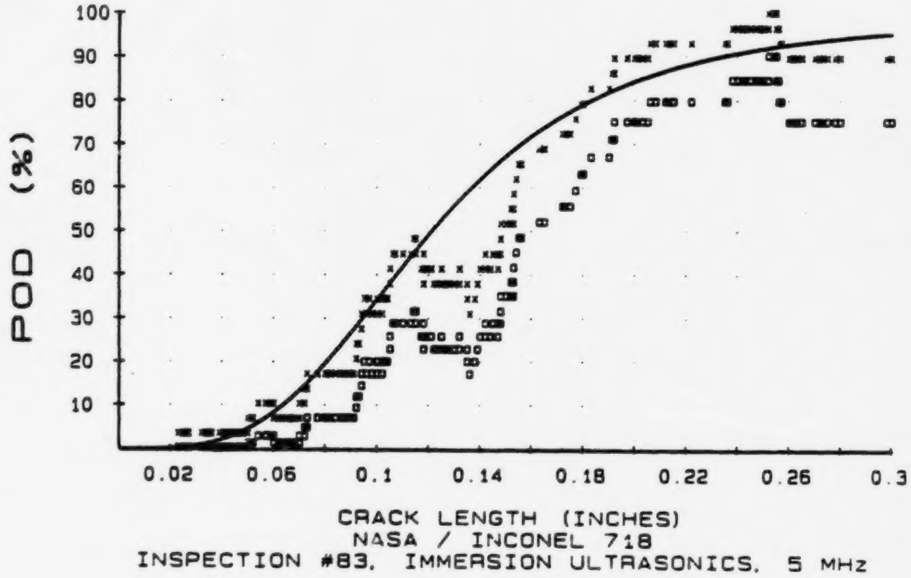
45 deg Contour Presentation

Figure 5-65
Examples of C-Scan and 45 deg Contour Data Presentations for Immersion Ultrasonic Inspection of Inconel 718 Specimens



Inspection #83
Inconel 718
110 Specimens
281 Cracks
54.8% Detected
25 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-66
POD Curves for Inspection # 83 Performed using an Automated Scan Immersion Ultrasonic Technique

Table 5-17
Summary of Ultrasonic Inspection Sequence Results

Insp. No.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
			.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
83	54.8	23.6	5.0%(1.4%)	23.3%(14.7%)	46.7%(35.6%)	93.3%(85.4%)
84	53.7	0.0	1.7%(0.1%)	35.0%(24.8%)	66.7%(55.4%)	100.0%(95.1%)
85	45.9	0.9	1.7%(0.1%)	33.3%(23.3%)	66.7%(55.4%)	96.7%(89.9%)

Several factors adversely effected the performance of the immersion ultrasonic inspection. The inspection personnel performing the automated immersion inspection were unfamiliar with the full capabilities of the system that was used. The air bubbles that collected on the specimens when placed in the immersion tank were not consistently removed prior to beginning the inspection. This resulted in high noise levels resulting from reflections from the air bubbles. The slight curvature of the specimens was not fully compensated for in the signal gate or in the scan profile resulting in some flaw signals falling outside the time-of-flight gate. The panels were scanned from 1 direction only with the sound beam direction fixed parallel to the direction of scanning. As a consequence, the signals from flaws that were not oriented exactly perpendicular to the scanning direction were reduced. Additional detection capability could have been obtained by using a lower acceptance criterion. However, the number of nonrelavent indications exceeding the gate would have increased resulting in a higher POFA level.

5.3.3 Hand Scan Contact Ultrasonic Inspections

The Inconel 718 test specimens were used to assess the flaw detection capabilities of a hand scan contact ultrasonic (shear wave) inspection procedure by completing 2 inspection sequences using 2 different operators. These inspections were performed using a portable ultrasonic instrument with a 10 MHz, 0.25 in. wide wedge transducer producing a 42 deg refracted angle in Inconel 718. Glycerin was used as the coupling material between the transducer and the test specimens. The inspectors scanned the specimens free-hand without any inspection aids. The sound beam was directed approximately parallel to the length of the panel. If a possible flaw indication was identified, the operators would adjust the angle of the transducer until the maximum signal was obtained.

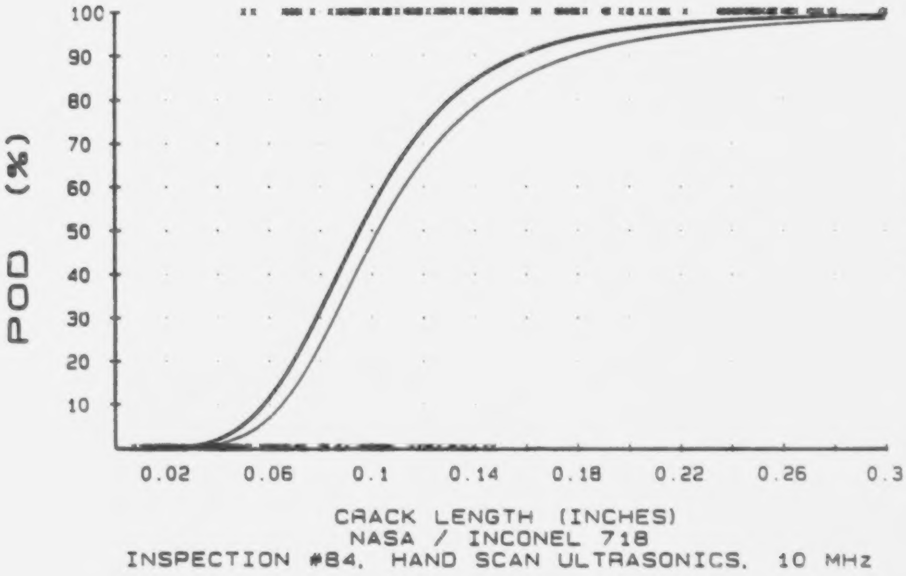
A 0.073 in. long fatigue crack with an estimated depth of 0.010 in. was selected from the test set to be used as a calibration standard. The gain was adjusted to produce a 90% screen height signal using this defect. Once the 90% screen height was obtained, the gain was adjusted to add 4 additional decibels. During scanning, the instrument alarm was set at 30% screen height to identify potential indications for further evaluation. The acceptance criterion for the inspection was 90% screen height. The inspections were conducted using certified level II operators and were performed as if they were production inspections. A a Martin Marietta engineer observed the performance of the inspections and determined the coordinates and documented the location of all cracks identified by the operator. The hand scan inspection set-up parameters are summarized as follows:

Frequency - 10 MHz
Transducer Size - 0.25 in. wide
Incident Angle - 37.5 deg
Refracted Angle - 42 deg
Couplant - Glycerin (Contact)
Calibration Defect - 0.073 x 0.010 in. Fatigue Crack
Calibration Amplitude - 90% Screen Height + 4 dB
Acceptance Criterion - 90% Screen Height
Gate (Time Base) - Second Leg

The results from these inspections were analyzed and plotted as POD curves using the moving average and maximum likelihood methods of analysis shown in Figures 5-67 and 5-68. The contact ultrasonic results (Inspections #84 and #85) are summarized in Table 5-17. Modified ROC diagrams showing the results of these inspections are shown in Figures 5-69 and 5-70 for the 0.051-0.100 in. and 0.101-0.150 in. flaw length ranges. The POD and ROC results show that the two inspectors demonstrated similar flaw detection capabilities using this hand scan procedure.

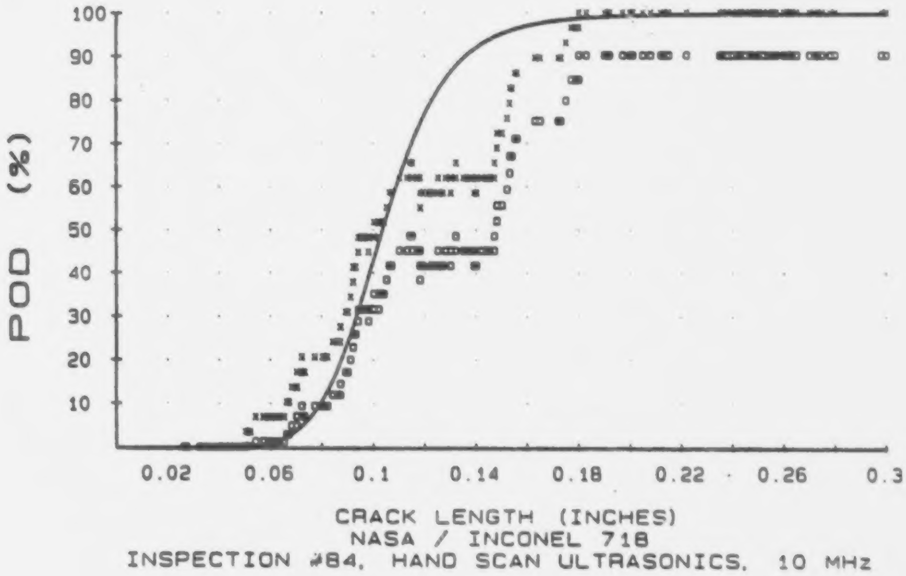
In recording the data for these inspections, an amplitude was recorded for all apparent cracks whether the 90% screen height criterion was exceeded or not. This was done to allow the data to be replotted at other acceptance criterion levels to detemine the effect of the acceptance criteria on crack detection performance. The effect of acceptance criteria on detection performance is discussed further in section 6.5.2.

The hand scan technique allowed the operators to more fully investigate each flaw indication that was detected and maximize the signal amplitude by adjusting the position of the transducer. This flexibility in directing the sound beam and the fact that curvature of the specimens did not change the position of the specimens within the time base gate resulted in the hand scan technique demonstrating better flaw detection capability than the automated immersion inspection. If all other variables are equal, an immersion technique will provide better and more consistent energy transfer from the transducer to the part than will a contact technique and as a result provide better flaw detection capability.



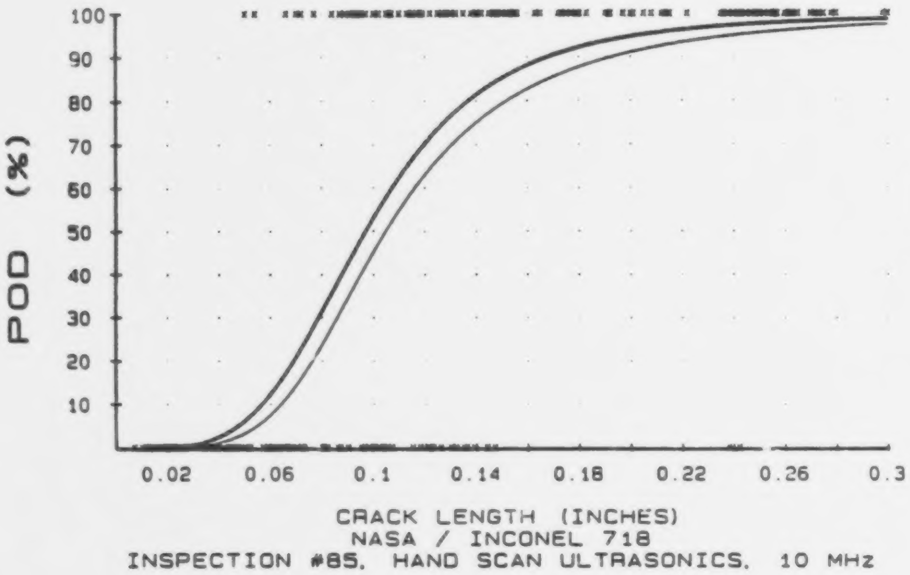
Inspection #84
Inconel 718
110 Specimens
281 Cracks
53.7% Detected
0 False Calls

Maximum Likelihood Analysis



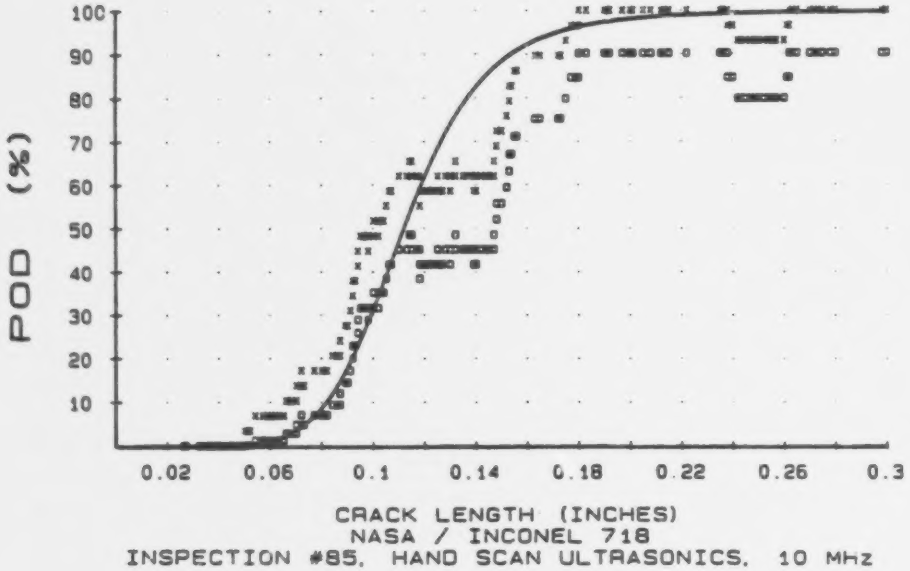
Moving Average Analysis

Figure 5-67
POD Curves for Inspection #84 Performed using a Manual Contact Ultrasonic Technique (90% Screen Height Acceptance Criterion)



Inspection #85
Inconel 718
110 Specimens
281 Cracks
45.9% Detected
1 False Call

Maximum Likelihood Analysis



Moving Average Analysis

Figure 5-68
POD Curves for Inspection #85 Performed using a Manual Contact Ultrasonic Technique (90% Screen Height Acceptance Criterion)

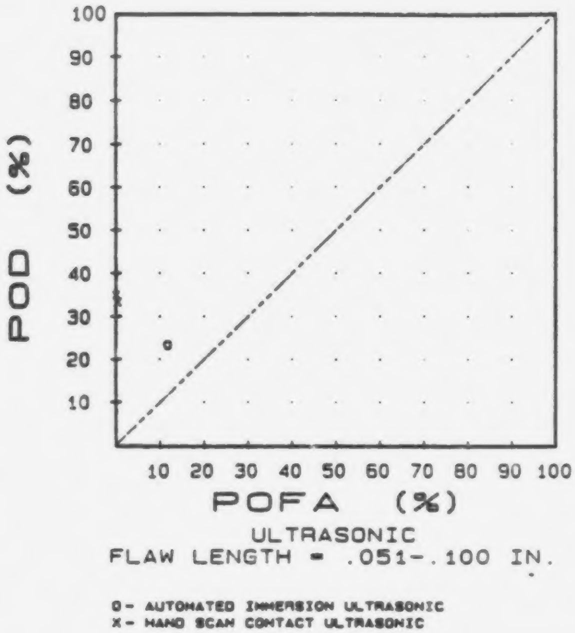


Figure 5-69
Modified ROC Analysis for Ultrasonic Inspection Sequences (0.051-0.100 in. Flaw Length Range)

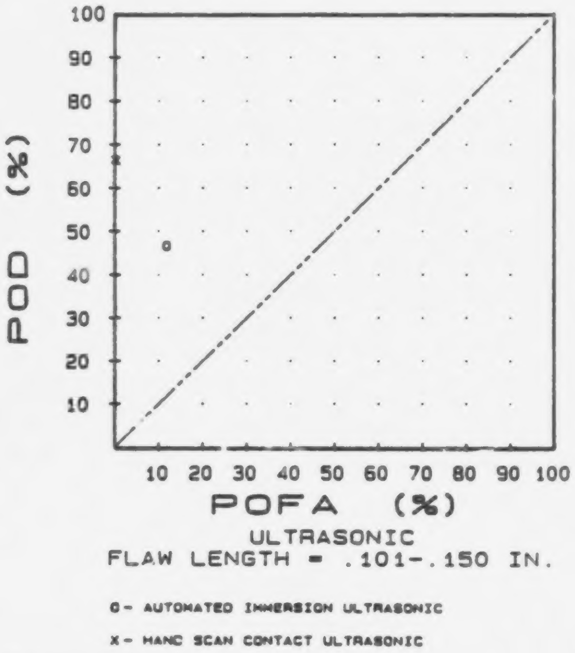


Figure 5-70
Modified ROC Analysis for Ultrasonic Inspection Sequences (0.101-0.150 in. Flaw Length Range)

6.0 DISCUSSION OF RESULTS

The eight organizations participating in the NDI reliability assessment program were extremely cooperative and helpful in providing the personnel and facilities necessary for conducting the inspection assessments. Their willingness to participate in the midst of sometimes extemely heavy production schedules was greatly appreciated.

In addition to the data collected from the eight organizations that participated directly in this program, the Inconel 718 and Haynes 188 specimens were used to generate NDI capability at the request of a number of other government and industry facilities. This data has been included in the results reported herein to augment the NDI capability data base.

At each of the facilities, the inspection procedures in production use were assessed to provide current capability data. Based upon the initial results, recommendations were made for improving performance and if possible, the changes were implemented. Additional inspection sequences were then performed to demonstrate the performance improvement resulting from the recommended procedural changes.

Each facility assessment was completed in a 2 to 3 week period with the number of inspection sequences completed ranging from 5 to 15. Outbriefings were conducted prior to exiting each facility to provide facility personnel with the preliminary results of the assessment. This proved to be an effective means of communicating the results of the assessments and helpful suggestions were exchanged both to increase production inspection performance and to increase the effectiveness of the assessments at future locations. Reports detailing the results from each location were prepared and distributed to the individual facilities. The facility results were then incorporated generically into the overall data base that is presented within this report.

The Inconel 718 and Haynes 188 test sets were very effective in assessing inspection performance and discriminating slight differences in inspection capability. The cleaning procedures developed during contract NAS8-34425 were found to be completely satisfactory for removing penetrant from the specimen defects between inspections. The specimens and data collection procedures used were found to be as effective for assessing the detection capabilities of ultrasonic and eddy current inspection procedures as they were for penetrant inspections.

6.1 DISCUSSION OF PENETRANT INSPECTION RESULTS

6.1.1 Inspection Materials

A number of different penetrant, emulsifier, remover, and developer materials were assessed during this program. In almost all cases the materials were used as supplied from the vendor. The materials were either being drawn directly from the manufacturer's containers or were contained in dip tanks that had been cleaned and charged with new material prior to beginning the assessment inspections. The aliquot samples that were taken of the materials used during the program revealed no instances of degraded material being used. Inspection sequences were performed to determine the effects of different materials and material combinations on flaw detection capability. Included were the effects of penetrant sensitivity level, emulsifier concentration, and type of developer.

6.1.1.1 Penetrants—The penetrants evaluated included materials listed in QPL-25135-15 as Type I, Sensitivity Level 2, 3, and 4 penetrants; Type II penetrants; and a self-developing fluorescent penetrant not included in QPL-25135-15. These penetrants were used with a variety of processing methods and forms of developer to provide a wide range of detection capabilities. It was found that the sensitivity level of the penetrant alone did not determine the detection capabilities of the inspections process. The average performance of the penetrant materials used during this program by type and sensitivity level is provided in Table 6-1.

Table 6-1
Average Flaw Detection Performance by Penetrant Type and Sensitivity Level

Pen. Type & Sensitivity Level	# of Insp.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit) .010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
Type II	6	72.9	0.7	31.5%(22.4%)	71.7%(61.2%)	89.4%(81.5%)	92.2%(84.6%)
Type I Sens. Level 2	3	74.2	3.3	15.8%(9.2%)	78.3%(68.1%)	98.3%(92.5%)	95.0%(87.6%)
Type I Sens. Level 3	25	84.1	9.5	55.1%(42.7%)	86.7%(78.3%)	94.1%(88.6%)	97.7%(91.0%)
Type I Sens. Level 4	14	77.2	19.8	46.4%(31.0%)	79.4%(67.6%)	87.1%(78.0%)	93.6%(84.5%)

Based on the total percentage of flaws detected, the Type II visible penetrants provided the lowest level of flaw detection followed by the Type I, Sensitivity Level 2 penetrants. The Sensitivity Level 3 penetrants provided the best detection capability, significantly outperforming the inspections that had been completed using Sensitivity Level 4 penetrants. When examining the performance at the 0.101-0.150 in. and 0.151-0.250 in. flaw length ranges as shown in Table 6-1, the Type I, Sensitivity Level 4 results are not significantly different from those obtained from the Type II visible penetrants. This apparent contridiction between sensitivity level and detection capability can be explained by the fact that the majority of Sensitivity Level 4 penetrant inspections were performed using Method D (hydrophilic emulsifier) and either dry powder or wet developer while the majority of Type II, and Type I Sensitivity Levels 2 and 3 penetrant inspections were performed using either Method A (water wash) or Method C (solvent removable) and nonaqueous wet developer. It will be shown in this discussion that the processing method and type of developer used determined the detection capability of the overall process to a greater degree than did the sensitivity levels of the penetrants.

The self-developing penetrant that was evaluated during this program did not provide enough developing action to be a reliable inspection method for the flaw lengths evaluated during this program. The average percentage of total flaws detected for this material when used without developer was 49.8% and was as low as 17.6% for an individual inspection. When compared with the average percentage of flaws detected using the penetrants listed in Table 6-1 (72.9% to 84.1%) it is readily apparent that the self-developing penetrant process did not have sufficient detection capability to provide a reliable inspection for the defect sizes contained in the Haynes 188 and Inconel 718 test specimens in a production environment using production inspection personnel.

When the self-developing penetrant is used in the conventional manner with the aid of a developer, the average percentage of flaws detected was 80.3% which would rank it as providing the second best performance of the penetrants listed in Table 6-1.

6.1.1.2 Removers/Emulsifiers--The solvent removers and hydrophilic emulsifiers used during this program were quality materials provided by reputable manufacturer's. No evidence of degraded or defective material was found during the analysis of the aliquot samples that were taken. Proper use of the hydrophilic emulsifiers though, was found to be a universal problem. Mixing the emuslifier to the proper concentration and then maintaining it to a narrow enough range to maintain consistent emulsification was a problem at all of the participating facilities using Method D.

6.1.1.3 Developers--The developers evaluated during this program included dry powder (Form a), soluble wet (Form c) and nonaqueous wet (Form d) developers. The form of the developer used was found to contribute significantly to the flaw detection capabilities of the penetrant inspection processes. In addition, considerable variability in the the performance of the same form of developer provided by different manufacturer's was found, particularly for soluble wet and dry powder developers. The average results obtained by the form of developer used are listed in Table 6-2.

Form d (nonaqueous wet) developer provided consistently better results than did the other forms of developer. It should be pointed out that all of the Type II visible penetrant inspections were performed using nonaqueous developer and these results were included in the average calculations listed in Table 6-2. If the averages had been taken using fluorescent penetrants only, the differential between the nonaqueous developer and the other forms of developer would have been even greater.

Table 6-2
Summary of Penetrant Inspection Results by Form of Developer

Developer Form	# of Insp.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
				.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
a (dry)	14	78.1	4.2	45.8% (30.6%)	80.1% (68.7%)	89.2% (79.2%)	95.4% (87.1%)
c (soluble wet)	8	75.0	34.7	36.9% (27.9%)	75.8% (66.1%)	88.7% (80.5%)	91.7% (83.6%)
d (nonaqueous)	38	82.0	7.8	48.2% (34.8%)	84.6% (76.2%)	94.2% (88.7%)	96.9% (90.2%)
None	14	49.8	21.3	21.7% (14.7%)	46.4% (37.1%)	57.0% (47.5%)	68.6% (58.8%)

A significant variability was found in the performance of similar developers provided by different manufacturers. This same variability in performance between similar materials from different manufacturer's was was not found in the penetrants and removers/emulsifiers. For instance the average percentage of flaws detected for inspections performed using dry powder developer from Manufacturer A was 85.6% based on 4 inspection sequences. These inspections were performed using Sensitivity Level 3 penetrants. The average percentage of flaws detected using the dry powder developer from Manufacturer B was 75.1% based on 10 inspection sequences. The majority of Manufacturer B inspections were performed using Sensitivity Level 4 penetrants.

6.1.2 Inspection Equipment

A wide range of penetrant inspection equipment was evaluted during this program. The inspections were completed using equipment ranging from hand processing using aerosol can materials to automated processing lines. The automated processing lines provided adherence to established processing parameters but were not flexible enough to allow adjustments to the process based on the hardware geometry and surface finish.

The manual dip tank and spray processing lines used during the program commonly had inadequate blacklight illumination in the penetrant wash stations. This made it difficult for the operators to achieve complete penetrant removal without overwashing. The degree of washing was much better controlled in those processing lines which had darkened wash stations with blacklights mounted overhead illuminating the hardware during the wash operation.

Other equipment variables encountered during the program included defective and missing wash nozzles, low intensity blacklights, inadequate ventilation for developer application, and inability to adequately darken the inspection area. When conditions such as these were observed, the condition was corrected, if possible, and a second inspection was performed to demonstrate the effect these variables had on performance.

6.1.3 Inspection Processes

Three basic penetrant processing methods were evaluated during this program. These included the water washable (Method A), solvent removable (Method C), and post-emulsifiable using hydrophilic remover (Method D) processes for both Type I (fluorescent) and Type II (visible) penetrants. The average results obtained during this program by penetrant type and processing method are listed in Table 6-3

Table 6-3
Summary of Penetrant Inspection Results by Type and Method

Type / Method	# of Insp.	% of Flaws Detected	% False Calls	POD (%) By Crack Length Range Point Estimate (Lower 95% Confidence Limit)			
				.010-.050 in.	.051-.100 in.	.101-.150 in.	.151-.250 in.
Type I Method A	32	83.7	8.3	51.4%(37.3%)	87.0% (78.5%)	95.3% (89.9%)	97.9% (91.4%)
Type I Method C	5	81.9	8.8	46.7% (37.0%)	85.5% (76.6%)	94.3% (87.4%)	97.0% (90.4%)
Type I Method D	17	75.4	18.5	41.3% (27.4%)	76.6% (65.0%)	86.7% (77.6%)	93.0% (84.0%)
Type II Method A	1	56.6	0.0	14.3% (7.7%)	48.3% (37.1%)	76.7% (65.9%)	78.3% (67.9%)
Type II Method C	5	76.2	0.8	34.9% (25.3%)	76.4% (66.0%)	91.9% (84.6%)	95.0% (87.9%)

The self-developing penetrant inspections performed without developer were not used to calculate the averages provided in Table 6-3.

The Type I penetrant inspections performed using Methods A (water wash) and C (solvent removable) provided very similar flaw detection capabilities. The average flaw detection capability of the Type I, Method D (hydrophilic emulsifier) inspections however, was significantly lower than the Method A and C results with a higher false call rate. This was due to the problems of properly maintaining emulsifier concentrations and adjusting emulsification times as emulsifier concentration and contamination levels changed. Such inadequacies in process control of the emulsifier baths and emulsification times resulted in diminished flaw detection capabilites and higher false calls.

A high degree of process control is required to maintain consistent emulsification and penetrant removal using the post-emulsification process. If this degree of process control cannot be achieved in the manufacturing environment, the results of this work indicate that either Method A or Method C would provide a more reliable inspection.

The results presented in Table 6-3 for Type II, Method A (visible, water wash) are based on the performance of 1 inspection only and may not be truly representative of the capabilities of this process.

The Type II, Method C (visible, solvent removable) results were obtained from 5 inspections and are considered representative of the capabilities of the materials and techniques used. These inspections were performed by hand processing using materials directly from the manufacturer's containers and were therefore less dependent on process control than a post-emulsification process. This is illustrated by the results provided in Table 6-3. The Type II, Method C inspections (visible penetrant) demonstrated better flaw detection capability than did the post-emulsifiable fluorescent penetrant inspections evaluated during this program.

6.1.4 Human Factors

6.1.4.1 Human Factor Influences on Results--Human factors are the final elements effecting the performance of an inspection process. If the initial NDI engineering has not been properly performed or if the inspection materials, processing, or equipment don't provide adequate flaw discrimination, the performance of the inspection will suffer to the degree the inspector is able to compensate. As a consequence, the inspection performance becomes overly dependent on the abilities of the individual inspectors. This was clearly demonstrated by the results of the self-developing penetrant inspections performed without developer. Without developer, the sensitivity of the process is severely reduced and the performance of the inspection becomes dependent on the eye-acuity of the inspection personnel. The modified ROC curve for the self- developing penetrant inspections performed without developer for the 0.101-0.150 in. flaw length range is shown in Figure 6-1.

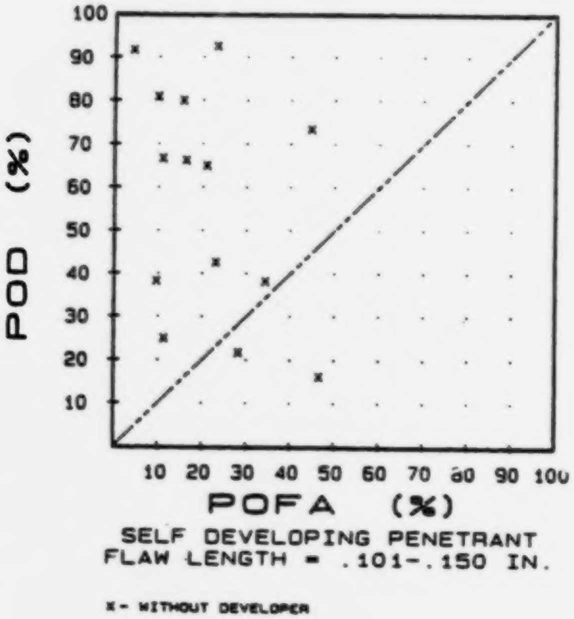


Figure 6-1
Modified ROC Diagram for Self-Developing Penetrant Process Showing Wide Performance Variation (0.101-0.150 in. Flaw Length Range)

This ROC curves shows the wide variation in performance that was obtained using the self-developing penetrant process. In contrast, the modified ROC curve for the Type I, Method A, Sensitivity Level 3 inspections for the same flaw length range is shown in Figure 6-2. This process is much less dependent on the ability of the inspection personnel and provided much more consistent results.

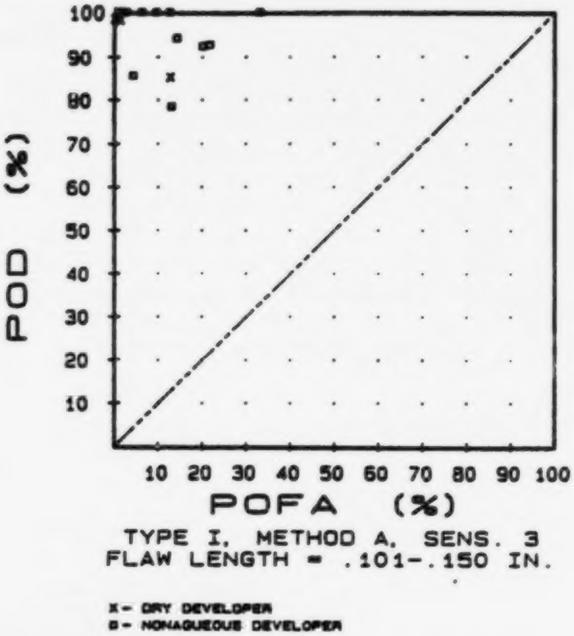


Figure 6-2
Modified ROC Diagram for the Type I, Method A, Sensitivity Level 3 Inspections Showing Less Dependence on Inspector Capabilities (0.101-0.150 in. Flaw Length Range)

6.1.4.2 Effectiveness of Assessment Procedures in Discriminating Human Factor Variables--The procedures used during this program for assessing the capability and reliability of penetrant inspection procedures were demonstrated to be effective in determining the relative abilities of inspection personnel. Care was taken prior to each inspection sequence to insure that the personnel participating in the program received the same level of orientation and instruction. The prerecorded sound/slide presentation that was used to brief each inspector guaranteed a common base of information that was supplemented by verbal instructions given by the assessment team. Once the orientation was completed, the inspectors were given no help during the course of an inspection sequence. In a few instances, individuals were asked to complete more than one inspection sequence. In these cases, for the subsequent inspections, the inspection personnel had a level of knowledge about the flaw locations and orientations on the panels that a first time inspector does not. However, due to the large number of specimens contained in the test sets (102-110) and the large number of cracks (281-284) this advantage was found to not effect the results significantly. It was observed that after a first time inspector had

inspected approximately 10 specimens, he became familiar enough with the crack location and orientation patterns that this advantage was nullified for the remainder of the inspection sequence. The number of specimens involved and their generic appearance made the possibility of memorizing crack locations for subsequent inspection sequences impossible.

As already shown in Figure 6-1, the data collection procedures were extemely effective in measuring a wide range of inspector capabilities for an inspection process that provided poor flaw discrimination capabilities. Figures 6-3 and 6-4 show modified ROC curves for 4 inspections performed on an automated penetrant processing line using the Type I, Method D process. The processing line automation insured that the penetrant material quantities and processing parameters used for the four inspections were identical. The only variable between the four inspections was the abilities of the four inspectors. Three of the four inspectors showed little variation in performance as might be expected from automated processing. The fourth individual however, performed at a significantly lower level and could be readily identified from the modified ROC diagrams as needing additional training or reassignment.

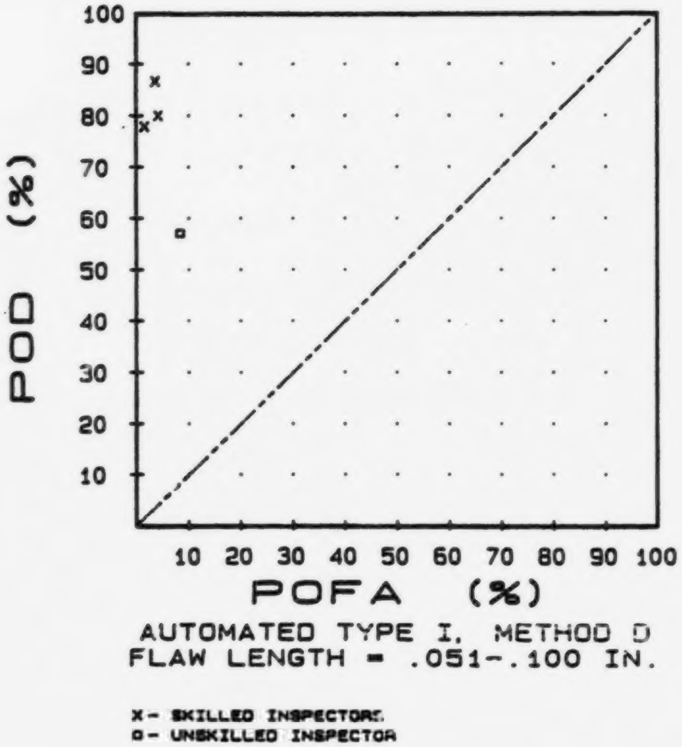


Figure 6-3
Modified ROC Diagram for Automated Type I, Method D Process, Identifying Less Skilled Inspector (0.051-0.100 in. Flaw Length Range)

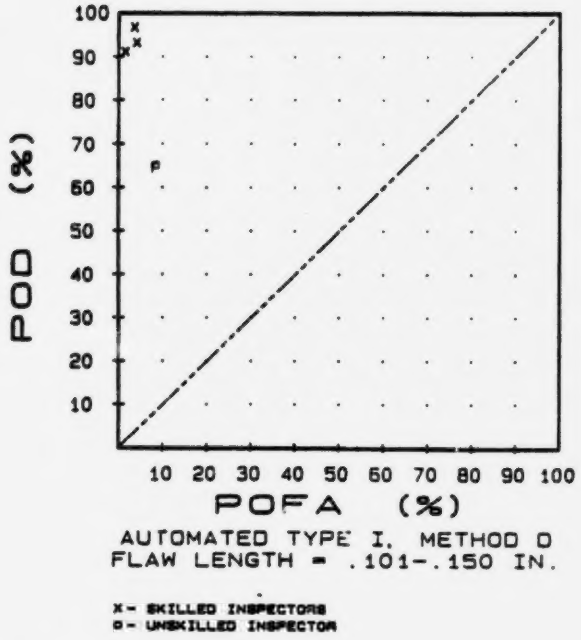


Figure 6-4
Modified ROC Diagram for Automated Type I, Method D Process, Identifying Less Skilled Inspector (0.101-0.150 in. Flaw Length Range)

6.2 EDDY CURRENT INSPECTION RESULTS

Four eddy current inspection sequences were completed using similar calibration/set-up procedures. The three inspections performed at 1 MHz produced very similar POD curves. The flaw length at which the POD curves crossed 90% detection ranged from 0.099 to 0.105 in. (0.018 to 0.020 in. flaw depth) based on the maximum likelihood analysis. Two of these were manual scan inspections and one was automated. The automated scan inspection produced more consistent results with a sharper transition from detection to no detection than did the manual inspections, but the overall detection capability was comparable.

The 500 kHz inspection produced 90% detection at flaw length of .120 in. (.022 in. flaw depth). The 500 kHz inspection was performed with a 0.750 in. dia probe versus 0.125-0.250 in. dia probes for the 1 MHz inspections. The much larger eddy current field size resulting from the larger probe and the increased depth of penetration obtained at 500 kHz resulted in a loss of sensitivity to smaller defects even though a comparable calibration was performed.

The detection capabilities of eddy current flaw detection on the Haynes 188 alloy could be increased by increasing the operating frequency to 2-3 MHz. The 500 kHz and 1 MHz frequencies used during this program were evaluated because these frequencies were being used for production inspections of materials with conductivities comparable to the Haynes 188 material and were familiar to the operators. Additional detection capability could be gained by decreasing the size of the calibration defect and or increasing the required calibration signal to noise ratio. The surface finish of the specimens resulted in a noise level that made detection of very small defects difficult. Improving the hardware surface finish would also result in an increase in the ability to distinguish the signals from small flaws from the background noise.

It was observed during the course of the manual eddy current inspections that inspection aids were not always available to the inspectors. It was recommended at those facilities as applicable that hole templates and plastic rulers should be available to aid the inspectors in achieving complete and consistent part coverage during inspections. Teflon tape should be available to provide consistent lift-off, ease scanning, and prevent probe wear. Eddy current standards are necessary for all material and flaw criteria inspection requirements to provide reliable and repeatable inspections.

6.3 ULTRASONIC INSPECTION RESULTS

Three induced shear wave ultrasonic inspection sequences were completed during this program. Two of the inspections were manual hand scan techniques and the third an automated scan immersion technique. The two hand scan inspections produced POD curves (maximum likelihood) that crossed 90% detection at 0.160-0.170 in. The immersion inspection was adversely effected by the slight curvature present in some of the Inconel 718 specimens and inexperienced inspection personnel. The flaw length at 90% detection for this inspection was 0.240 in.

The amount of energy reflected by a defect during an ultrasonic inspection is dependent on the surface area of the reflector. The aspect ratios (depth/length) of the cracks in the Inconel 718 and Haynes 188 test specimens generally range from .2 to .3. An increase in the flaw aspect ratio increases the surface area for reflection and improves the detectability of the defects. The length of flaws detectable by the techniques assessed during this program would as a result decrease with an increase in the flaw aspect ratios.

One major advantage the manual ultrasonic technique had over the automated inspection was the ability of the inspectors to adjust the direction of the sound beam to maximize flaw signals. The transducer position and direction of sound were fixed for the automated immersion inspection. Even though the sound was directed at an angle perpendicular to the flaw orientations, the maximum flaw signal was not always obtained.

The detection capabilities of the immersion inspection could have been improved by fully compensating for the curvature of the specimens in the signal gate and scan profile and by completing multiple scans with variations in the direction of the sound beam.

6.4 DISCUSSION OF DATA COLLECTION PROCEDURES

The data collection procedures used and validated during this program proved to be effective for assessing the flaw detection capabilities and reliability of penetrant, eddy current and ultrasonic inspection techniques. Some of the features of the data collection procedures used which proved critical to the success of the program included:

1) Discipline in following specimen cleaning procedures between inspection sequences.
2) Consistency in the orientation and instruction of inspection personnel. The initial degree of nervousness of the personnel participating in the program varied widely. The use of the pre-recorded slide presentation and specific instructions minimized the effects of operator uneasiness on the overall results.
3) Constant observation of specimen processing and inspection by a member of the Martin Marietta assessment team. This insured the well being of the test specimens and consistency in processing and inspection throughout an inspection sequence.
4) Coordination of assessment requirements with the participating facilities in advance of beginning on-site data collection.

The on-site data analysis that was performed immediately following an inspection sequence allowed for adjustments to be made to the test matrix prepared for each facility based on the initial results. This resulted in the most efficient use of the time available for data collection at each facility visited. It also provided an immediate measure of the performance of the inspection processes assessed and allowed for on-site demonstration of the performance improvements possible through process optimization. Reliance on off-site data analysis upon completion of the data collection phase would have resulted in a program that was much less responsive to the needs and conditions of the participating facilities.

The use of the full test sets containing 281-284 fatigue cracks provided more than sufficient data for a very rigorous statistical analysis of inspection capability and reliability using a variety of analysis methods. The use of partial test sets containing 68-90 fatigue cracks allowed for more variables to be examined in the limited amount of time available at each facility for data collection. The 68-90 flaws contained in the specimens subsets used still exceeded the minimum data requirements for a valid assessment using the maximum likelihood method of data analysis (Ref. 6-1). The use of specimen subsets to evaluate process variables was found to be effective and allowed the assessment team to make more efficient use of the data collection time that was available.

6.5 COMPARISON OF DATA ANALYSIS METHODS

A variety of data analysis methods were presented and used in the evaluation of the data generated in this program. The analyses that were applied were used to estimate detection capabilities through the use of POD curves and to provide a measure of an inspection technique's ability to discriminate valid flaw indications from nonrelevant indications. The inspection discrimination analyses were made through the use of the ROC and threshold diagrams.

6.5.1 Probability of Detection Analysis

The results from each inspection sequence completed on a full test set were analyzed and plotted as POD curves using the moving average and maximum likelihood methods of analysis. For the automated eddy current inspection, which produced quantitative signal amplitudes, the $\hat{a}$ versus a method of analysis was used in addition to these two methods. The moving average method was used to remain consistent with previous NASA NDI reliability assessment programs. The Air Force has adopted the maximum likelihood method as a standard method for calculating NDI performance and this method was included in this report to allow comparisons to be made between the data collected during this progam and other programs that have used the maximum likelihood method. Each of the methods calculates POD differently and are effected to different degrees by the flaw distribution of the test set, the quantity of data available and the amount of variance in the experimental data. The POD curves generated during this program were compared to determine the difference in results obtained between the two methods. Table 6-4 lists the crack lengths at which the curves plotted from the experimental data cross 90% POD for the Type I, Method D inspections performed on the full Inconel 718 or Haynes 188 test sets. The moving average flaw lengths were determined from the curve fit to the point estimates of POD.

Table 6-4
Crack Lengths at 90% POD for the Maximum Likelihood and Moving Average Analysis Methods (Type I, Method D Inspections)

Insp.	Crack Length (in.) @ 90% POD	
No.	Maximum Likelihood	Moving Average
47	.270	.265
48	.150	.148
49	.087	.080
50	.200	.220
51	.280	.305
52	.110	.105
53	.128	.120
54	.081	.083
55	.302	.250
59	.105	.115
60	.130	.140
61	.120	.093
62	.090	.095
63	.160	.220

Of the 14 Type I, Method D inspections listed in Table 6-4, the maximum likelihood method provided the most conservative estimate of POD for 7 of the inspections and the moving average method provided the most conservative estimate of POD for the other 7 inspections based on the flaw length at 90% POD. The average of the absolute value of the method differentials for the 14 inspections is 0.016 in. However individual inspection estimates varied as much as .060 in.

Making a comparison of the lower 95% confidence values provided by the two analysis technques is difficult. The moving average method does not produce a confidence curve but a series of points calculated from the detection results for each of the overlapping intervals. As a result, the confidence bounds generated using this method tend to be very erratic. The maximum attainable POD for the confidence bound using an overlapping sample size of 29 is 90%. Consequently, the largest flaw missed automatically drops the confidence bound below 90%. Of the 85 inspections completed during this program, 61 missed 1 or more flaws larger than 0.200 in. including some of the inspections demonstrating the best overall performance. Since the moving average method used for this program plots the point estimate and confidence bound at the largest flaw in each group of 29 flaws, the confidence bound as plotted on the POD curves drops below 90% at the length of the 29th flaw larger than the longest flaw missed. As a result, for the moving average method the flaw length at which the 95% confidence bound dropped below 90% was well in excess of the 0.200 in. for the majority of inspections completed during this program. This sensitivity to the outcome from a single flaw regardless of the total number of flaws inspected results in an overly conservative estimate of the 95% confidence bound.

The confidence bound for the maximum likelihood method is based on the variance of the observed data from the assumed model (log logistic) using the estimated model parameters. Because the confidence bound is influenced by the total number of flaws inspected as well as the variance in the inspection data, rather than being based on an artificial sample size of 29, the maximum likelihood method provides more accurate confidence bounds.

6.5.2 Effect of Inspection Acceptance Criteria

The detection capabilities of inspection procedures that produce a quantitative signal response are determined to a large extent by the acceptance criterion that is applied to make the accept/reject decision. If the acceptance criterion is at too high of level, some flaws will be accepted resulting in a low POD. The detection capability can be increased by lowering the acceptance criterion, however a corresponding increase in POFA can usually be expected. Establishing the proper operating point is vital prior to implementing an inspection procedure in production.

The effects of acceptance criteria on detection capability can be demonstrated using the data generated during this program. Figure 6-5 shows the threshold diagram plotted for the automated scan eddy current inspection (Inspection #82).

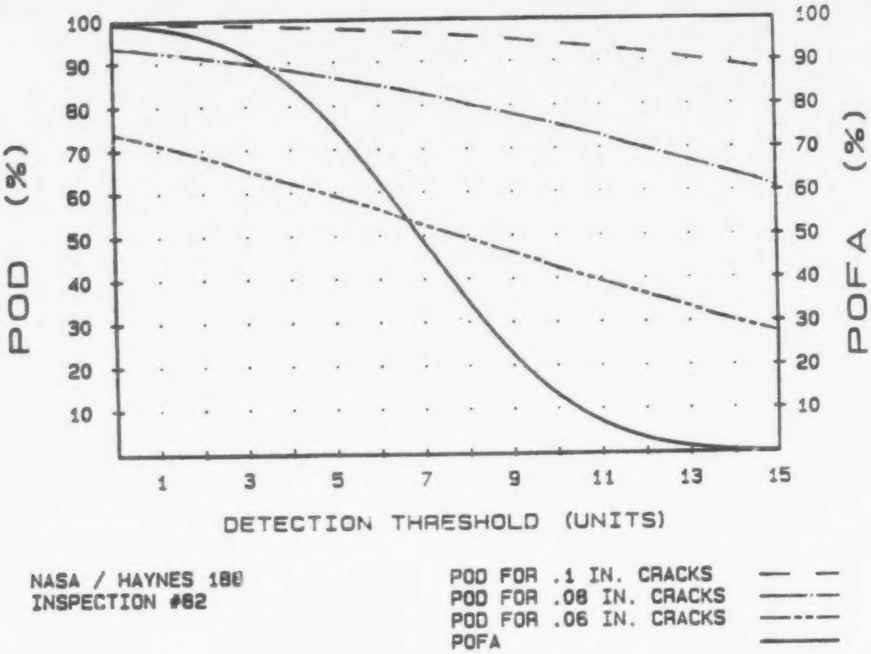


Figure 6-5
Threshold Diagram for Automated Scan Eddy Current Inspection (Insp. #82)

This diagram provides a convenient means of analyzing the POD and POFA levels that will be obtained at varying acceptance criterion levels. An acceptance criterion of 11 divisions was selected as the lowest accept/reject threshold that could be used and still maintain an acceptable false call rate (less than 10% POFA). By decreasing the acceptance criterion to 7 divisions, a slight improvement in POD can be obtained as shown by the POD curves in Figure 6-6. However, this improvement in detection is accompanied by an increase in POFA from 7% to 48%.

In contrast, a more dramatic improvement in the detection capabilities of the hand scan ultrasonic procedures evaluated during this program could have been obtained by lowering the threshold at which the accept/reject decision was made. The 90% screen height acceptance criterion that was applied by the inspectors was significantly above the noise distribution that was produced by this inspection technique. The noise values recorded ranged from 5% to 45% of screen height. The acceptance criterion for these inspections could have been lowered to 45% screen height to obtain additional detection capability without an appreciable increase in the false call rate.

POD curves for Inspection #85, showing the performance obtained at acceptance criteria of 45% and 90% are shown in Figure 6-7. As these curves illustrate, lowering the acceptance criterion from 90% to 45% shifted the flaw length at 90% POD from .170 in. to .125 in. This gain was made without increasing POFA.

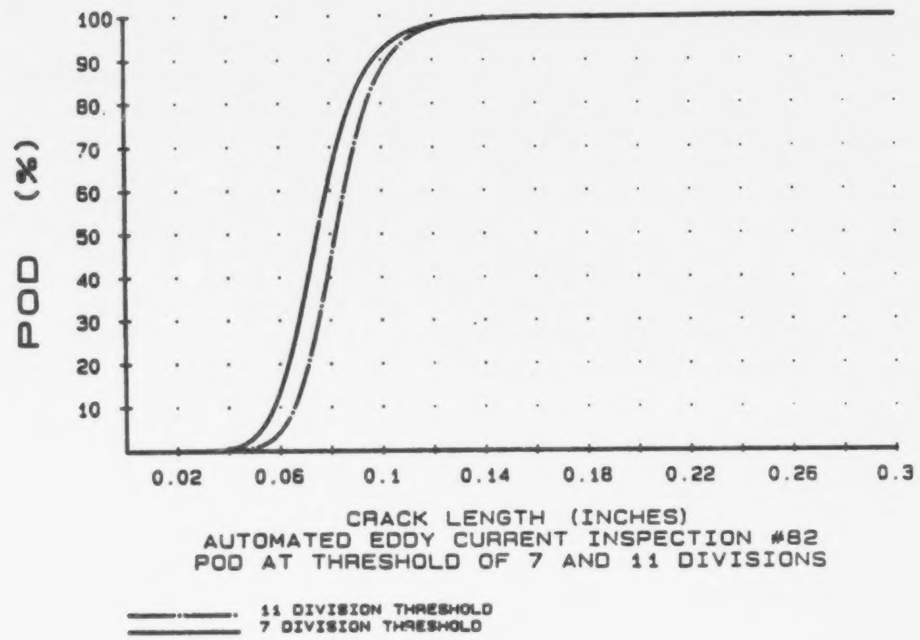


Figure 6-6
POD Curves (Maximum Likelihood) for the Automated Scan Eddy Current Inspection (Insp. #82) Using Acceptance Criteria of 7 and 11 Divisions

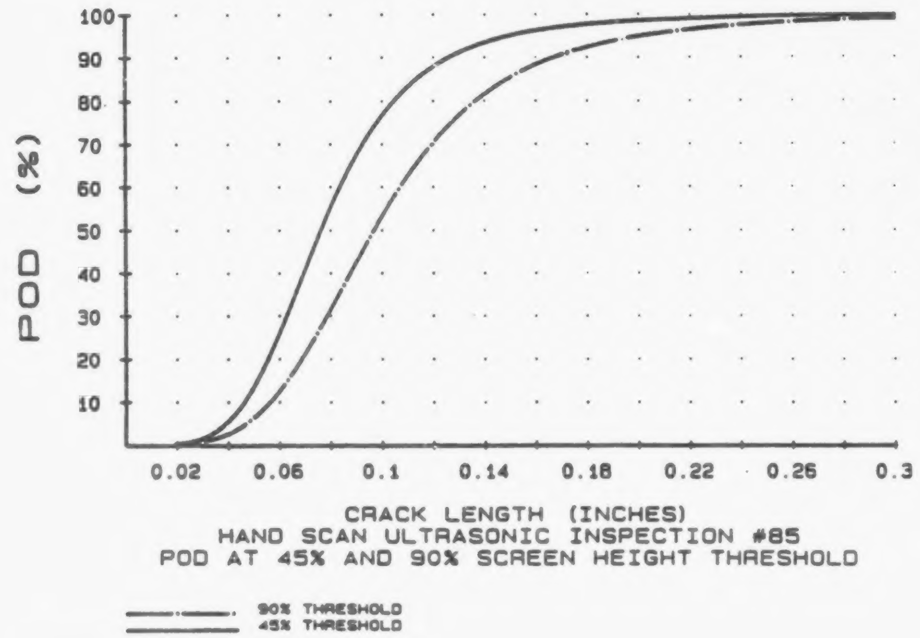


Figure 6-7
POD Curves (Maximum Likelihood) for a Hand Scan Ultrasonic Inspection (Insp. #85) Using Acceptance Criteria of 45% and 90% Screen Height

6.5.3 Inspection Discrimination Analysis

The POD curve is the primary tool that has been used for presenting NDI capability and reliability data. It does not however, provide any information on the ability of an inspection process to discriminate nonrelavent indications from actual defects. Achieving a high POD at the expense of a high POFA is not representative of a reliable production inspection. The ROC method of comparing the discrimination capabilities of individual inspections was used extensively during this program. As demonstrated in this work, the ROC method provides a convenient means of visually comparing the ability of individual inspectors or processes to perform within established bounds for detection capability and false call percentages.

For inspections that produce quantitative signal data, the threshold diagram (Fig. 6-5) provides a convenient means of presenting the relationship between POD and POFA as the inspection accept/reject criteria changes. This method was used in evaluating the automated eddy current inspection data and was used to determine the acceptance criteria that produced the highest POD while maintaining an acceptable false call rate.

REFERENCES

6-1. A.P. Berens, and P.W. Hovey: Flaw Detection Reliability Criteria, Volume I - Methods and Results. AFWAL-TR-84-4022, April 1984.

7.0 CONCLUSIONS

This program was conducted with objective of surveying industry NDE practices and capabilities, and generating quantitative NDE flaw detection capability data for the NDE techniques typically practiced by aerospace contractors. From the substantial data base that was collected, the minimum size crack that can be reliably detected for the different inspection methods that were assessed can be estimated and used to update previous flaw detectability assumptions such as those contained in MSFC-STD-1249, "Standard NDE Guidelines and Requirements for Fracture Control Programs".

In generating the data base, procedures for data collection, data analysis, and specimen care and maintenance were developed, demonstrated and validated. The Inconel 718 and Haynes 188 specimens and the NDE assessment procedures demonstrated during this program give NASA the capability to quantitatively measure the detection capabilities of specific inspection procedures being applied to current and future fracture control hardware.

7.1 EXTENSIVE QUANTITATIVE DATABASE GENERATED

During this program 85 inspection sequences were completed presenting a total of 20,994 fatigue cracks to 53 different inspectors. This total included 78 penetrant, 4 eddy current, and 3 ultrasonic inspections. This data base allows the production detection capabilities of a number of penetrant inspection procedures to be accurately estimated and provides additional data on the detection capabilities of production eddy current and ultrasonic inspections.

The penetrant inspection results showed that the form of developer used and the effectiveness of the process control applied effected results to a greater extent than did the sensitivity level of the penetrant. Inspections that were performed with Form d (nonaqueous wet developer) on average outperformed all other inspections performed with other forms of developer regardless of penetrant type and processing method. The Method D (hydrophilic post-emulsifiable) inspections performed poorly compared to the other processing methods due to the difficulty in maintaining emulsifier concentrations and contamination levels to a narrow enough range to maintain consistent emulsification in a high-volume production environment.

The manual and automated scan eddy current inspection procedures performed at 1 MHz demonstrated very similar flaw detection capabilities. The automated procedure provided more consistency in the signal amplitude obtained as a function of flaw length. The manual inspections were slightly less consistent missing more larger flaws, but the inspectors were able to detect more of the smaller flaws than the automatic inspection with the effect of showing very similar performance after analysis.

The 500 kHz eddy current inspection provided equally good detection capability at the longer flaw lengths but was less sensitive to small flaws due to the large diameter probe used (0.75 in.) and the increased depth of penetration produced at the lower operating frequency. Improved detection at 500 kHz could be obtained by the use of a probe better suited to the detection of small flaws.

The 2 hand scan ultrasonic inspection sequences produced detection capabilities similar to that obtained with a number of the penetrant inspection processes. The automated immersion inspection was hampered by the one direction scan and fixed sound beam direction and as a result provided detection capabilities less than that demonstrated by the manual scan contact mode. This inspection demonstrated the importance of performing multiple scans with different sound beam paths to achieve optimum detection capability using an ultrasonic technique.

7.2 NDE NOMINAL DETECTABILITY LIMITS

Sufficient data was collected during this program to estimate nominal detectability limits for a number of penetrant inspection procedures performed in production or field environments. These limits (Table 7-1) are the minimum crack sizes deemed reliably (90% probability, 95% confidence) detectable by the properly applied techniques assessed during this program. The values presented in Table 7-1 are the lower 95% confidence interval values (assuming a normal distribution) of the flaw lengths at 90% POD for the individual inspections that were properly performed. Those inspections that were deemed improperly performed were not used in making the calculations. The flaw lengths at 90% POD were calculated using the maximum likelihood analysis. Detectability limits have been estimated for only those techniques where a minimum of 5 inspection sequences were completed on a full test set.

Table 7-1
Liquid Penetrant Inspection Nominal Detectability Limits
For Fatigue-Type Defects with $a/2c = 0.2$

Penetrant Type	Method	Developer Form	Minimum Detectable Crack Size (90%/95%)
II (Visible)	C	d (Nonaqueous)	0.219 in.
I (Self-Dev.)	A	None	0.416 in.
I (Self-Dev.)	A	d	0.117 in.
I (Sens.Lvl 3)	A	d	0.086 in.
I (Sens.Lvl 3)	C	d	0.129 in.
I (Sens.Lvl 4)	D	a/b (dry/wet)	0.164 in.

The Type I, Method D (hydrophilic emulsifier) inspections were adversely effected by poor process control of emulsifier concentration, emulsifier contamination, variable emulsification times, and poorer performing developers. Post-emulsification penetrant processing requires stringent process control for the capabilities of the technique to be realized in a production environment.

The Inconel 718 and Haynes 188 test specimens have a flaw aspect ratio of approximately 0.2. The detectability limits for flaws with aspect ratios greater than 0.2 may be somewhat improved.

The detectability limit (90% detection, 95% confidence) for the 1 MHz eddy current inspection procedures evaluated during this program were 0.110-0.125 in. long (0.021-0.023 in. deep) flaws. The detectable flaw length for higher aspect ratio flaws would decrease. The eddy current inspections were hindered by the short period of time available for the inspectors to develop calibration and inspection procedures. Additional detection capability could be gained by using a higher frequency (2-3 MHz), smaller calibration defects and or higher calibration signal to noise ratio, better hardware surface finish, and lower acceptance criterion values.

The hand scan contact ultrasonic inspection procedures produced detectability limits of 0.160-0.170 in. (90% detection, 95% confidence). These limits could have been reduced by optimizing the calibration procedures, using aids to ensure complete coverage during hand scanning, and reducing the inspection acceptance criterion level.

7.3 DEMONSTRATION OF ASSESSMENT PROCEDURES

The procedures used to collect and analyze the data from the 85 inspection sequences completed during this program were demonstrated to be effective in making quantitative measurements of inspection process and inspection personnel capabilities. The procedures demonstrated included:

1) Prearrangement of logistics for data collection,
2) Briefings for management and supervisory personnel,
3) Inspection personnel orientation,
4) Data collection techniques,
5) Data analysis techniques for on-site quantification of inspection performance, and
6) Specimen care and maintenance.

The procedures developed for use during this program allowed the assessments at the 8 facilities visited to be completed smoothly and within the time period orignally scheduled for on-site data collection. On-site data analysis capability allowed to the Martin Marietta assessment team to respond real-time to performance problems that were identified during the data collection phase. The 85 inspection sequences were completed with no apparent degradation in the detectability of the defects contained in the test sets validating the cleaning procedures developed during contract NAS8-34425.

The test specimens and data collection procedures were found to be equally effective in providing a quantitative measure of the detection capabilities of a variety of inspection processes and in comparing the relative performance of different inspection personnel.

The test specimens and procedures demonstrated during this program will be of much value to NASA in meeting their requirements to quantify the detection capabilities of inspection procedures and certify the inspection personnel being used by NASA contractors during the manufacture and maintenance of fracture critical hardware. This type of quantitative inspection capability information is critical to the effective management of current and future space program damage tolerant designs.

7.4 RECOMMENDATIONS

The Haynes 188 and Inconel 718 test specimens and the data collection and analysis procedures used for this program were demonstrated to be an effective means of quantitatively measuring the flaw detection capabilities of penetrant, eddy current and ultrasonic inspection methods. A significant amount of variation was observed in the training, process control, equipment, materials, and philosophies used at the different facilities evaluated during this program. These variations resulted in a wide range of detection capabilities and points to the need for the implementation of a controlled survey of industry practices as they are being applied to fracture control programs. The test specimens and methodology demonstrated during this program will be of great value to NASA in the management of the space shuttle, space station and payload/experiment programs to insure that the inspection procedures being applied can provide the detection capabilities required to insure fail-safety.

A.0 APPENDIX A
DATA ANALYSIS AND GRAPHIC PRESENTATION METHODS

This appendix presents the data analysis techniques used in the reduction and analysis of the NDE assessment data. The maximum likelihood, moving average, and $\hat{a}$ versus a methods of analyses used for generation of the POD curves contained in the NDE Detectability of Fatigue-Type Cracks in High-Strength Alloys NDE Assessment report are described. Also included is a description of the use of the $\hat{a}$ versus a analysis method in generating the inspection threshold diagram plotted for the automated scan eddy current inspection sequence.

A.1 MAXIMUM LIKELIHOOD POD ANALYSIS

The maximum likelihood POD curves plotted for each inspection sequence completed during the NDE assessment program were generated using the logodds POD model of Equation A-1.

[A-1]
$$\mathrm{POD}(a) = \frac{\exp[\alpha + \beta \ln(a)]}{1 + \exp[\alpha + \beta \ln(a)]}$$

Maximum likelihood estimation of the POD model parameters is based on the concept of determining the values for the unknown parameters, α and β, which would produce the highest probability of obtaining the observed data. To obtain the maximum likelihood estimates of α and β, the following procedure adopted from Berens and Hovey (Ref. A-1) and Berkson (Ref. A-2) was used.

The maximum likelihood estimates for α and β must satisfy the following simultaneous equations.

[A-2]
$$0 = \sum_{i=1}^{n} n_i p_i - \sum_{i=1}^{n} \frac{n_i \exp[\alpha+\beta \ln(a_i)]}{1+\exp[\alpha+\beta \ln(a_i)]}$$

and

[A-3]
$$0 = \sum_{i=1}^{n} n_i p_i \ln(a_i) - \sum_{i=1}^{n} \frac{n_i \ln(a_i)\exp[\alpha+\beta \ln(a_i)]}{1+\exp[\alpha+\beta \ln(a_i)]}$$

where p_i=1 if the flaw was detected and p_i=0 if the flaw was not detected for single inspection per flaw data and p_i equals the proportion of times an individual crack was detected for multiple inspections per flaw data, and n_i equals the number of times the i_{th} flaw was inspected.

Letting $\hat{p}_i=\exp(\alpha+\beta\ \ln(a_i))/[1+\exp(\alpha+\beta\ \ln(a_i))]$, Equations A-2 and A-3 can be rewritten as:

[A-4] $$0 = \sum_{i=1}^{n} n_i(p_i - \hat{p}_i)$$

and

[A-5] $$0 = \sum_{i=1}^{n} n_i \ln(a_i)(p_i - \hat{p}_i)$$

Equations A-4 and A-5 are solved iteratively using initial estimates of the parameter values, α_o and β_o, obtained from the moving average and logodds regression technique described in Section A.2.

Corrections to α and β ($\Delta\alpha$ and $\Delta\beta$) for each iteration were obtained using the logit of $\hat{p}_i$, $\hat{l}=\alpha+\beta(\ln(a_i))$, $\hat{q}_o = 1-\hat{p}_i$ and the approximation $(\hat{p}_o-\hat{p}_i)=(l_o-l_i)\hat{p}_o\hat{q}_o$ given by the first term of a Taylor's expansion. The equations for estimating $\Delta\alpha$ and $\Delta\beta$ then become:

[A-6] $$\sum n_i p_i - \sum n_i \hat{p}_o - \Delta\alpha \sum n_i \hat{p}_o \hat{q}_o - \Delta\beta \sum n_i \hat{q}_o x_i = 0$$

and

[A-7] $$\sum n_i p_i x_i - \sum n_i \hat{p}_o x_i - \Delta\alpha \sum n_i \hat{p}_o \hat{q}_o x_i - \Delta\beta \sum n_i \hat{p}_o \hat{q}_o x_i^2 = 0$$

where $x_i = \ln(a_i)$.

These equations yield solutions for $\Delta\alpha$ and $\Delta\beta$ as follows:

[A-8] $$\Delta\beta = \frac{\sum p_i x_i - \sum \hat{p}_o x_i - \sum w_i x_i \ (\sum p_i - \sum \hat{p}_o) \ / \sum w_i}{\sum w_i x_i^2 - (\sum w_i x_i)^2 \ / \sum w_i}$$

[A-9] $$\Delta\alpha = \frac{\sum p_i - \sum \hat{p}_o - \Delta\beta \sum w_i x_i}{\sum w_i}$$

where $w_i = \hat{p}_o\hat{q}_o$ and n_i divides out when all values of n_i are equal.

The revised estimates obtained with these corrections are used as new provisional values in the iterative solution, which when it converges to finite values, yields the maximum likelihood estimates for α and β from which the POD can be calculated.

[A-10] $$\text{POD}(a) = \frac{\exp[Y(a)]}{1+\exp[Y(a)]}$$

where $Y(a) = \alpha + \beta \ln(a)$.

For very large sample sizes, estimates of the variances and covariance of α and β can be used for calculation of a lower confidence bound on $Y(a)$ as follows:

[A-11]

$$Y_L(a) = \alpha + \beta \ln(a) - Z_\gamma \sqrt{S(\alpha)^2 + 2\ln(a)S(\alpha\beta)^2 + [\ln(a)]^2 S(\beta)^2}$$

where

γ	is the confidence level.
Z_γ	satisfies $P(Z < Z_\gamma) = \gamma$ for the standard normal distribution
$S(\alpha)^2$	is the estimate of the variance of α.
$S(\alpha\beta)^2$	is the estimate of the covariance of α and β.
$S(\beta)^2$	is the estimate of the variance of β.

$S(\alpha)^2$, $S(\alpha\beta)^2$ and $S(\beta)^2$ are calculated using the following Information Matrix.

[A-12]

$$\begin{bmatrix} S(\alpha)^2 & S(\alpha\beta)^2 \\ S(\alpha\beta)^2 & S(\beta)^2 \end{bmatrix} = \begin{bmatrix} I_{11} & I_{12} \\ I_{21} & I_{22} \end{bmatrix}^{-1}$$

where

[A-13]

$$I_{11} = \sum \frac{\exp[\alpha + \beta \ln(a)]}{[1 + \exp(\alpha + \beta \ln(a))]^2}$$

[A-14]

$$I_{12} = I_{21} = \sum \frac{\ln(a)\exp[\alpha + \beta \ln(a)]}{[1 + \exp(\alpha + \beta \ln(a))]^2}$$

and

[A-15]

$$I_{22} = \sum \frac{[\ln(a)]^2 \exp[\alpha + \beta \ln(a)]}{[1 + \exp(\alpha + \beta \ln(a))]^2}$$

Using $Y_L(a)$, the lower confidence bound can be calculated.

[A-16]

$$POD_L(a) = \frac{\exp[Y_L(a)]}{1 + \exp[Y_L(a)]}$$

A.2 MOVING AVERAGE AND LOGODDS REGRESSION POD ANALYSIS

The NDE assessment moving average method POD curves were generated by first sorting the inspection data files containing crack lengths and detection/miss data by crack length from longest to smallest. To achieve a 90% probability/95% confidence level (MIL Handbook No. 5, B values) a moving 29 crack sample, starting with the 29 longest flaws was used to reduce the data to a set of *n* pairs, (a_i, p_i), where a_i is the crack length for the longest flaw in each 29 crack sample and p_i is the point estimate (percentage) of flaws detected for each 29 crack sample. For each point estimate, a lower 95% confidence value was plotted at the corresponding crack length based on a binomial distribution analysis using the following equation:

[A-17]
$$G = 1 - \sum_{x=s}^{N} \begin{bmatrix} N \\ x \end{bmatrix} (P_i)^{x} (1-P_i)^{N-x}$$

The 29 crack sample was successively incremented down 1 crack overlapping the previous sample by 28 cracks to generate the *n* data pairs with corresponding lower confidence values.

Given the *n* pairs of (a_i, p_i) data points, a curve was fit to the points using a logodds transformation and linear regression technique described by Berens and Hovey (Ref. A-1). The logodds transformation was performed as follows:

[A-18]
$$Y_i(a) = \ln \left[\frac{(p_i)}{(1-p_i)}\right] \text{ and } X_i = \ln(a)$$

Since the transformation of p_i to Y_i is undefined when $p_i=0$ or $p_i=1$ the values of 0.0001 and 0.9999 were substituted for 0 and 1 respectively when necessary.

Using the transformed variables the linear form of the POD function becomes:

[A-19]
$$Y(a) = \alpha + \beta X_i$$

Estimates for α and β were calculated by applying linear regression analysis to the transformed data points X_i and Y_i as follows:

[A-20]
$$\beta = \frac{\sum_{i=1}^{n} X_i Y_i - \frac{\sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i}{n}}{\sum_{i=1}^{n} X_i^2 - \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{n}}$$

and

[A-21] $$\alpha = \overline{Y} - \beta\overline{X}$$

where

[A-22] $$\overline{Y} = \frac{\sum_{i=1}^{n} Y_i}{n} \quad \text{and} \quad \overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

The inverse Y transformation was then applied to give the estimate of the POD:

[A-23] $$POD(a) = \frac{\exp[\alpha + \beta \ln(a)]}{1 + \exp[\alpha + \beta \ln(a)]}$$

A.3 $\hat{a}$ VERSUS a POD ANALYSIS

The $\hat{a}$ versus a analysis method of estimating POD as described by Berens and Hovey (Ref. A-1) is based on the probability that $\hat{a}$ (signal amplitude) will exceed the detection threshold ($\hat{a}_{th}$). To apply the $\hat{a}$ versus a method of analysis, the inspection data must be modeled so that:

[A-24] $$\hat{a} = f(a) + c + e$$

where $f(a)$ represents the mean trend in $\hat{a}$ as a function of a (crack length), c is the variance component due to flaw to flaw variations and e is the variance component due to inspection to inspection variations. The terms c and e are random variables with means equal to 0 and variances equal to $s_c{}^2$ and $s_e{}^2$. For a data set consisting of a single inspection per flaw, the mean and variance of $\hat{a}$ for a flaw of size a is:

[A-25] $$E(\hat{a}/a) - f(a), \text{ and}$$

[A-26] $$Var\ (\hat{a}/a) = s_c^2 + s_e^2$$

The automated scan eddy current inspection sequence data was assessed using the function $f(a)$ in the linear form:

[A-27] $$\hat{a} = \alpha + \beta(a) + c + e$$

If the variables c and e are assumed to be normally distributed, the POD function can be obtained as follows:

[A-28] $$\text{POD}(a) = P\,(\hat{a} > \hat{a}_{th})$$

[A-29] $$= \Phi\left[\frac{(\alpha + \beta a) - \hat{a}_{th}}{s}\right]$$

[A-30] $$= \Phi\left[\frac{(a) - \left(\dfrac{\hat{a}_{th} - \alpha}{\beta}\right)}{s/\beta}\right]$$

where

[A-31] $$s = \sqrt{s_c^2 + s_e^2}$$

and $\Phi(x)$ is the standard normal distribution function. Equation A-30 is the form of a lognormal distribution with a mean and standard deviation of crack length (a) given by:

[A-32] $\mu = (\hat{a}_{th} - \alpha)/\beta$, and

[A-33] $\sigma = s/\beta$

The parameters for the linear model, α, β, and s were estimated by applying the linear regression technique described by Equations A-20 through A-22 to the values of a and $\hat{a}$ where:

[A-34] $X = a$, and $Y = \hat{a}$

and s is estimated by:

[A-35] $$s = \sqrt{\frac{1}{n-2} \sum_{i=1}^{n} (Y_i - \alpha - \beta X_i)^2}$$

A lower confidence bound for the $\hat{a}$ versus a estimate of POD can be calculated from the estimates of μ and σ for the POD function as follows:

[A-36] $$\text{POD}_{CL}(a) = \Phi\,(Z_{CL})$$

where

[A-37] $$Z_{CL} = \hat{z} - \sqrt{\frac{\lambda}{n}\left[\frac{\hat{z}^2}{2} + \frac{(X-\bar{X})^2}{SSX} + 1\right]}$$

$\emptyset(x)$ is the standard normal distribution function,

n is the sample size,

λ is the P_{th} percentile of a Chi-Square distribution with 2 degrees of freedom,

[A-38] $$z = \frac{X-\mu}{\sigma}$$

[A-39] $$SSX = \sum_{i=1}^{n} X_i^2 - \frac{\sum_{i=1}^{n} X_i^{\,2}}{n}$$

A.4 SPECIFICITY DIAGRAM ANALYSIS

The threshold diagram showing POD and POFA as a function of inspection threshold level used in describing the results of the automated eddy current inspection was generated using the $\hat{a}$ versus a techniques described above. The POD lines on the specificity drawings were plotted by selecting three values for crack length (a). The three values of a were each then held constant while plotting over a range of detection threshold values ($\hat{a}_{th}$) using Equation A-30. The range of $\hat{a}_{th}$ values were selected to overlap the envelope of noise amplitudes.

The POFA line on the specificity curve was plotted by calculating the percentage of noise values exceeding the detection threshold over the range of $\hat{a}_{th}$ values. One noise value was recorded for each panel and was defined as the largest noncrack indication from the on the panel inspection that could not be readily explained by a visual inspection of the panel surface.

REFERENCES

A-1. A.P. Berens and P.W. Hovey: Flaw Detection Reliability Criteria, Volume 1 - Methods and Results. AFWAL-TR-84-4022, April 1984.

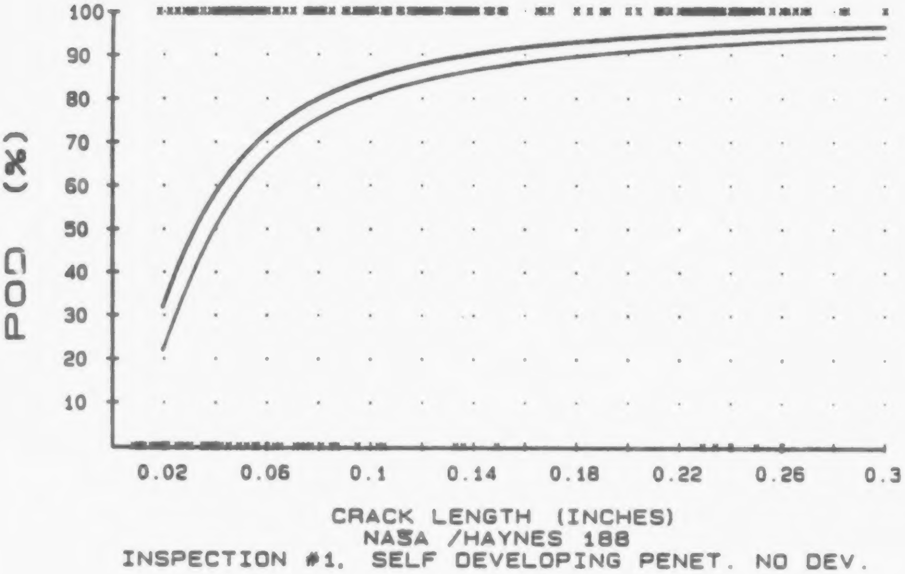
A-2. Joseph Berkson, M.D.: "Tables for the Maximum Likelihood Estimate of the Logistic Function". Biometrics. V.13, 1957.

B.0 APPENDIX B
NDE ASSESSMENT INSPECTION SEQUENCE POD CURVES

This appendix presents POD curves for each inspection sequence completed during the NDE assessment program. Two POD curves are shown for those inspections completed using the full Inconel 718 or Haynes 188 test sets. These curves were generated using the maximum likelihood and moving average methods of analyses. The data from those inspections completed using test specimen subsets are presented using the maximum likelihood method only due to the reduced quantity of data available. The POD curves for the eddy current inspection sequences have been plotted as function of both crack length and estimated crack depth.

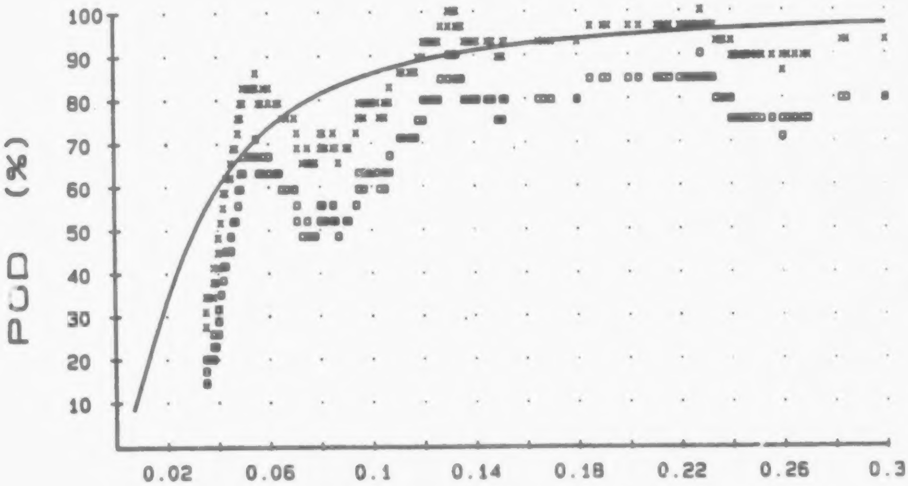
The maximum likelihood POD curves show both a mean and lower 95% confidence interval curve that have been calculated as described in Appendix A. In addition to the two curves, an "x" has been plotted for each crack contained in the test set. If a crack was successfully detected an "x" was plotted at 100% POD at the corresponding crack length. If a crack was missed the "x" was plotted at 0% POD.

Those POD curves plotted using the moving average method show an "x" plotted at the point estimate for each of the overlapping 29 crack samples at the longest crack length within the sample. The corresponding lower 95% confidence interval for each point estimate calculated using a binomial distribution analysis was plotted as a "box" again at the longest crack length within each 29 crack sample. A curve was fit to the point estimate data using a log logistic transformation and linear regression analysis described in Appendix A.



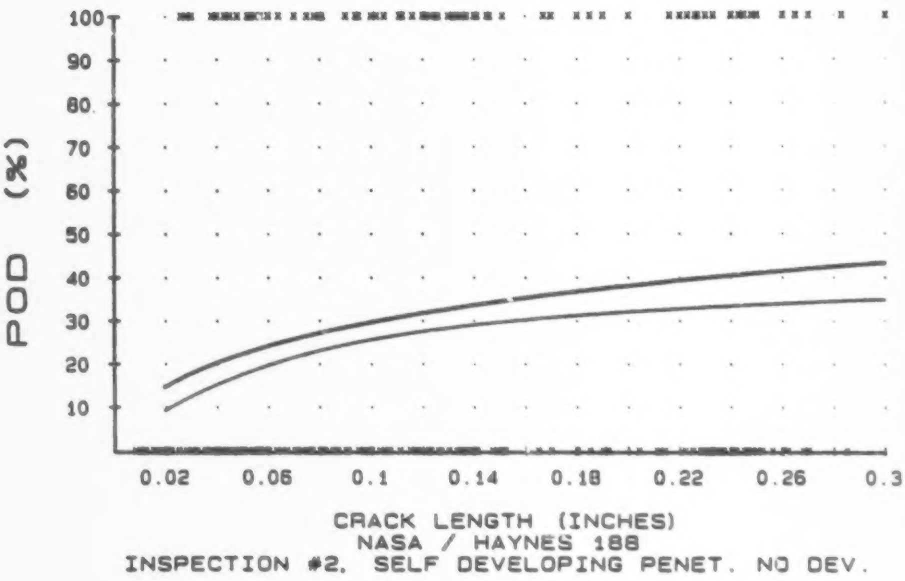
Inspection #1
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
78.5% Detection
47 False Calls

Maximum Likelihood Analysis



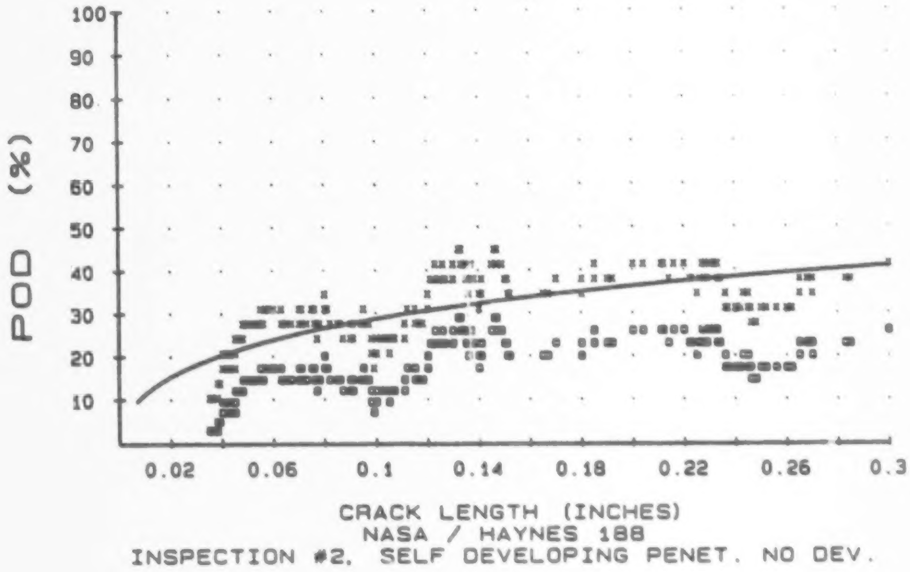
Moving Average Analysis

Figure B-1 Inspection #1 POD Curves



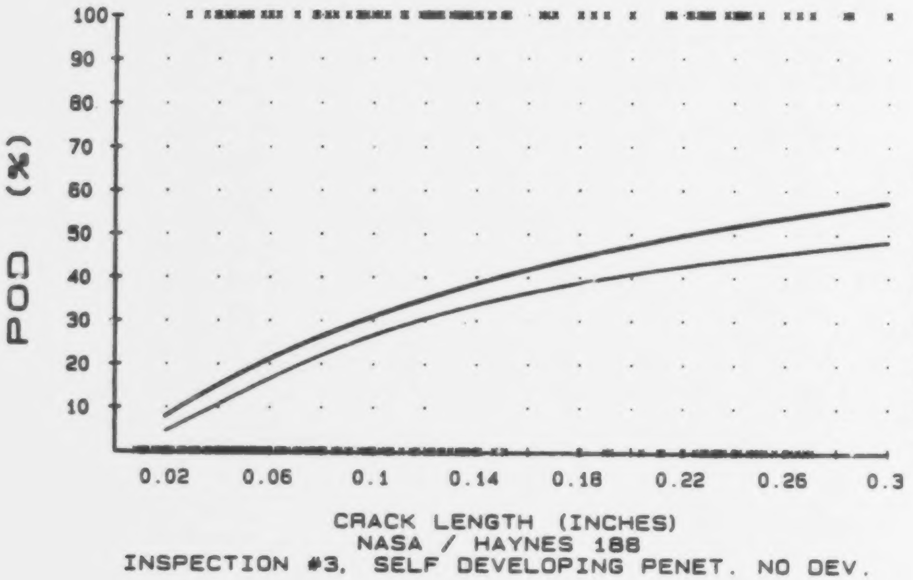
Inspection #2
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
29.9% Detection
70 False Calls

Maximum Likelihood Analysis



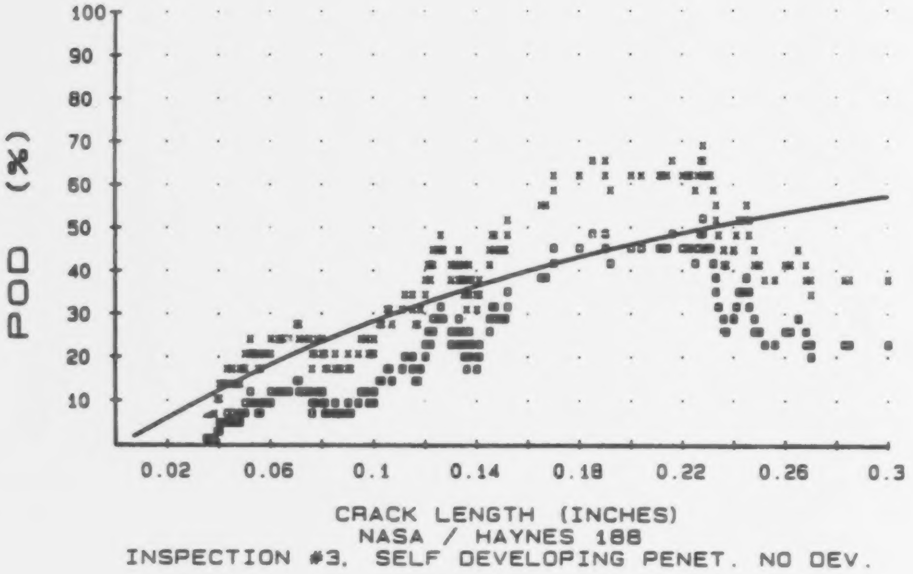
Moving Average Analysis

Figure B-2 Inspection #2 POD Curves



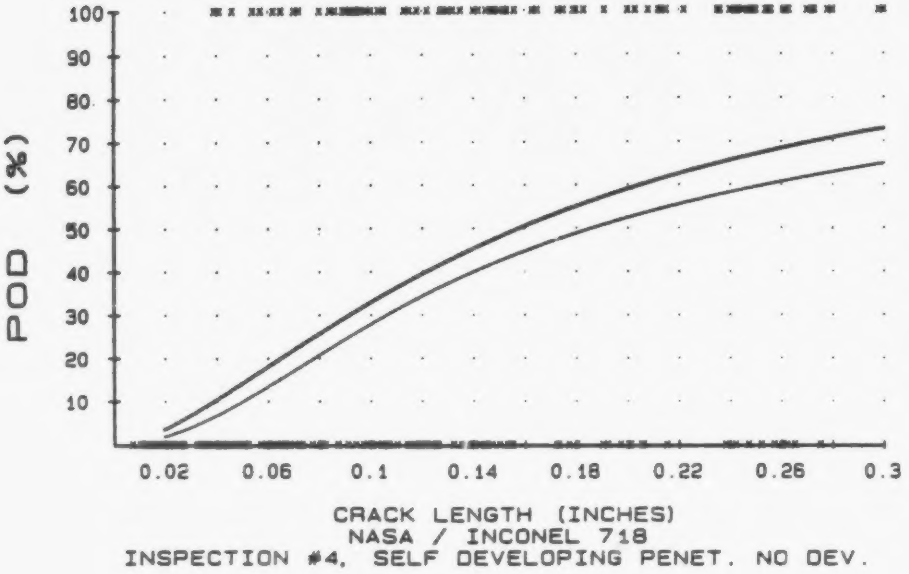
Inspection #3
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
32.4% Detection
47 False Calls

Maximum Likelihood Analysis



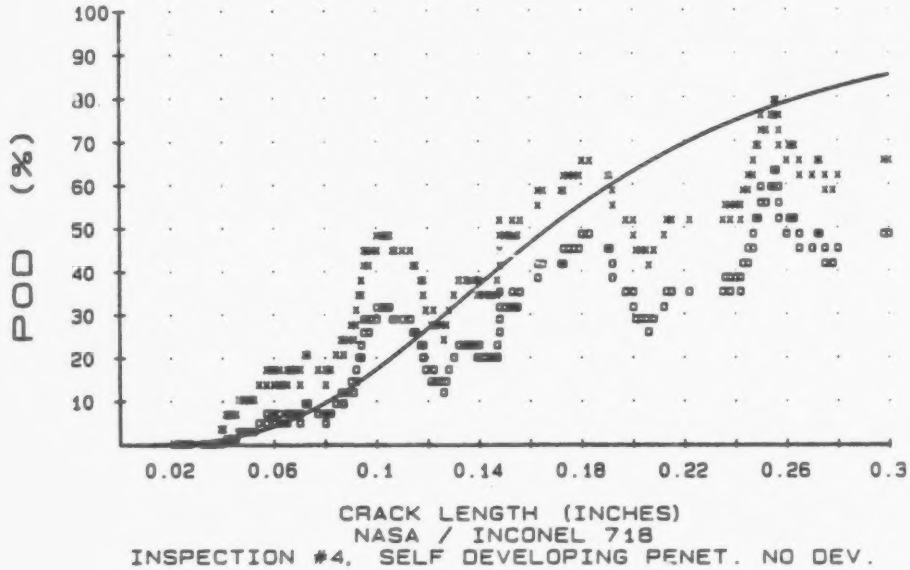
Moving Average Analysis

Figure B-3 Inspection #3 POD Curves



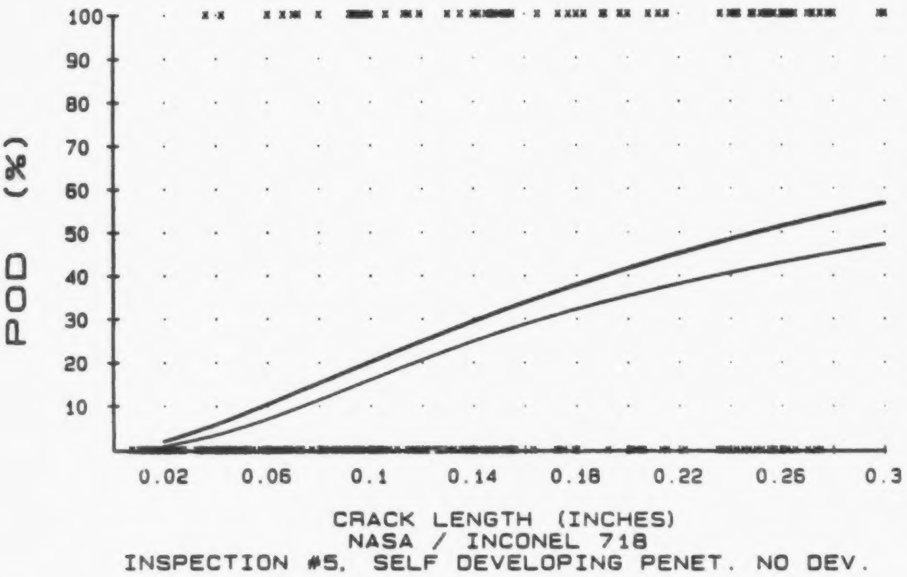
Inspection #4
Type I Penetrant
Self-Developing
Method A
Developer N/A
Inconel 718
110 Panels
281 Cracks
37.4% Detection
21 False Calls

Maximum Likelihood Analysis



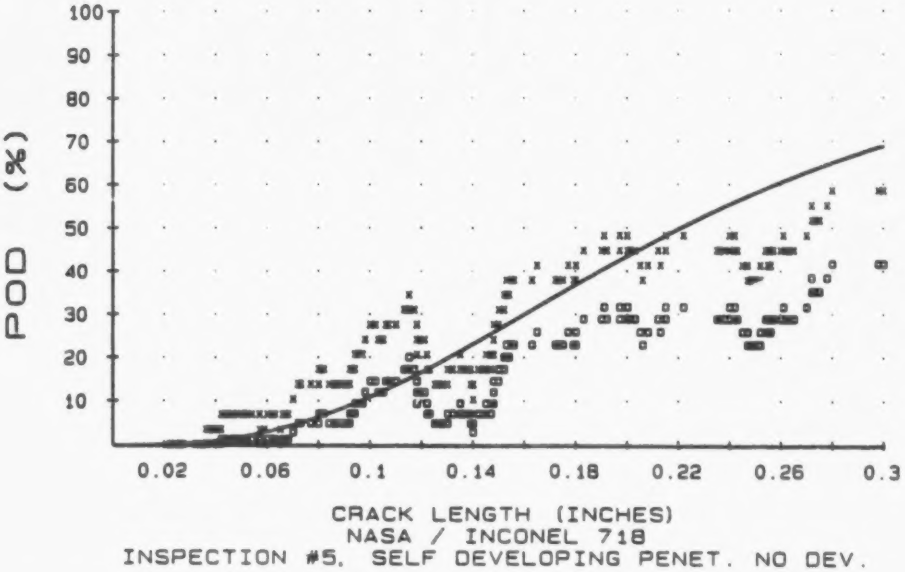
Moving Average Analysis

Figure B-4 Inspection #4 POD Curves



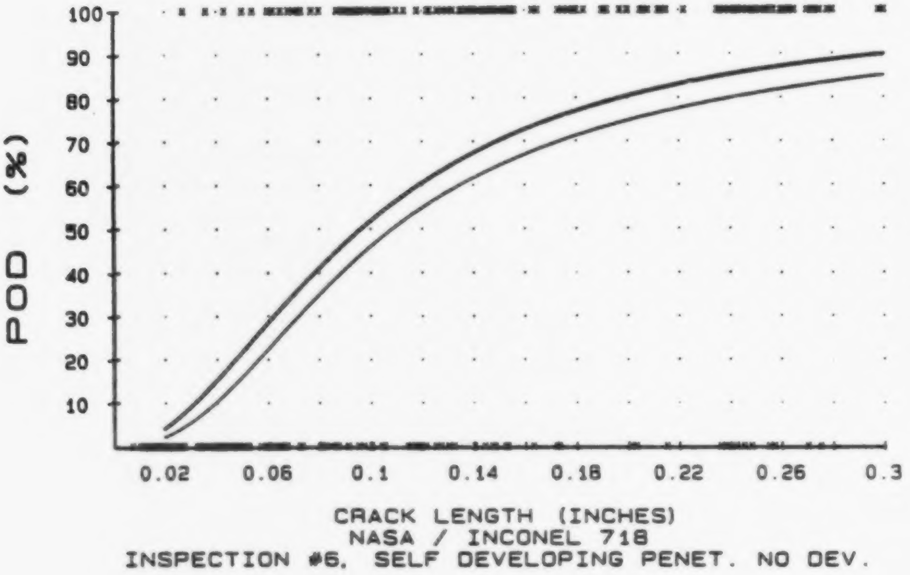
Inspection #5
Type I Penetrant
Self-Developing
Method A
Developer N/A
Inconel 718
110 Panels
281 Cracks
25.6% Detection
62 False Calls

Maximum Likelihood Analysis



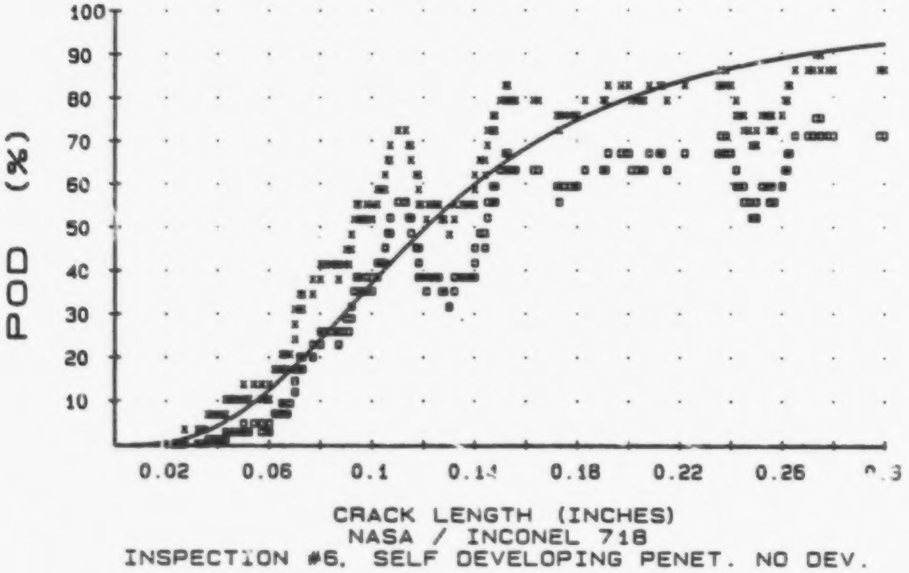
Moving Average Analysis

Figure B-5 Inspection #5 POD Curves



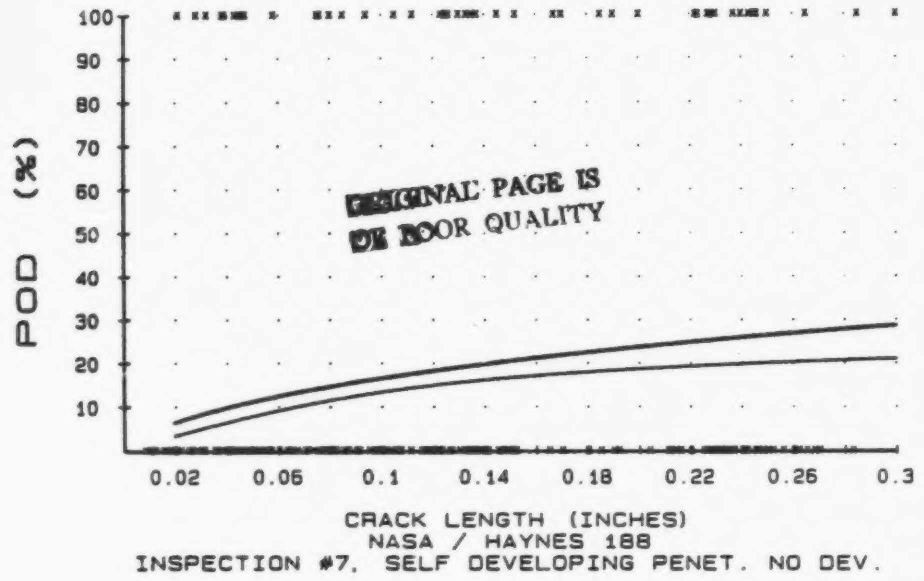
Inspection #6
Type I Penetrant
Self-Developing
Method A
Developer N/A
Inconel 718
110 Panels
281 Cracks
52.3% Detection
24 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure B-6 Inspection #6 POD Curves



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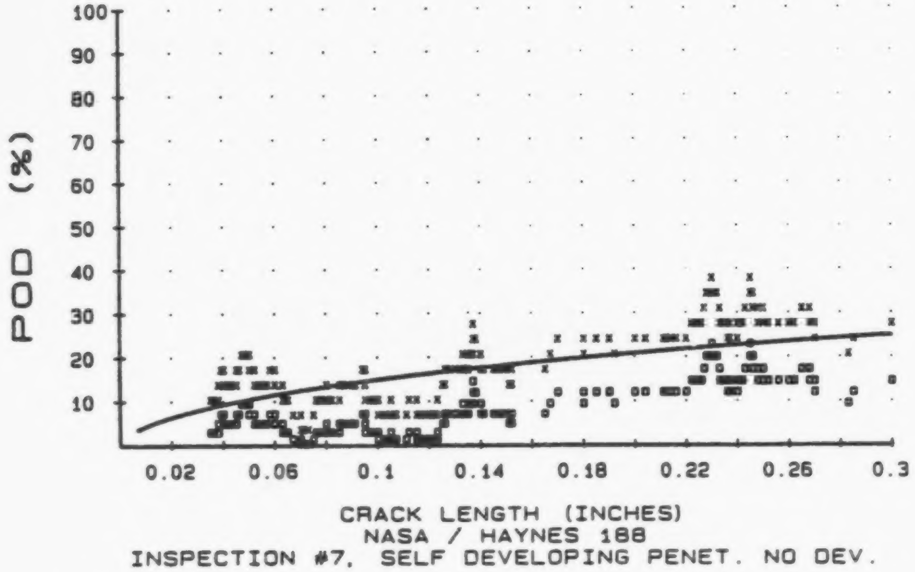
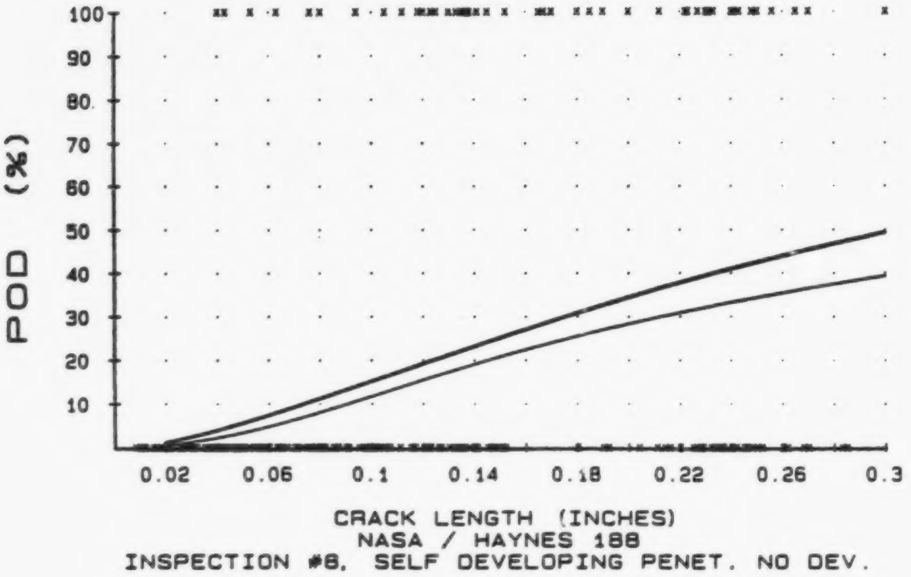
Inspection #7
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
17.6% Detection
95 False Calls

Maximum Likelihood Analysis



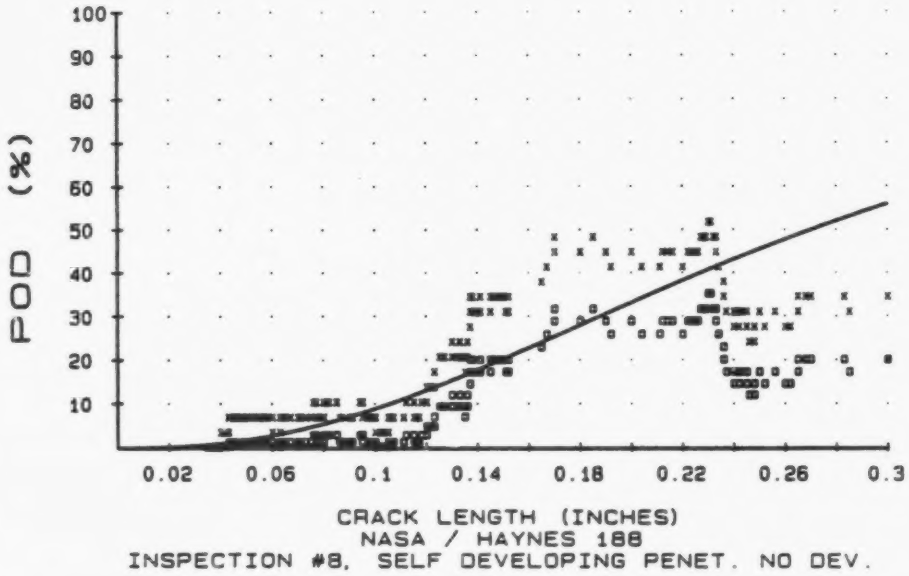
Moving Average Analysis

Figure B-7 Inspection #7 POD Curves



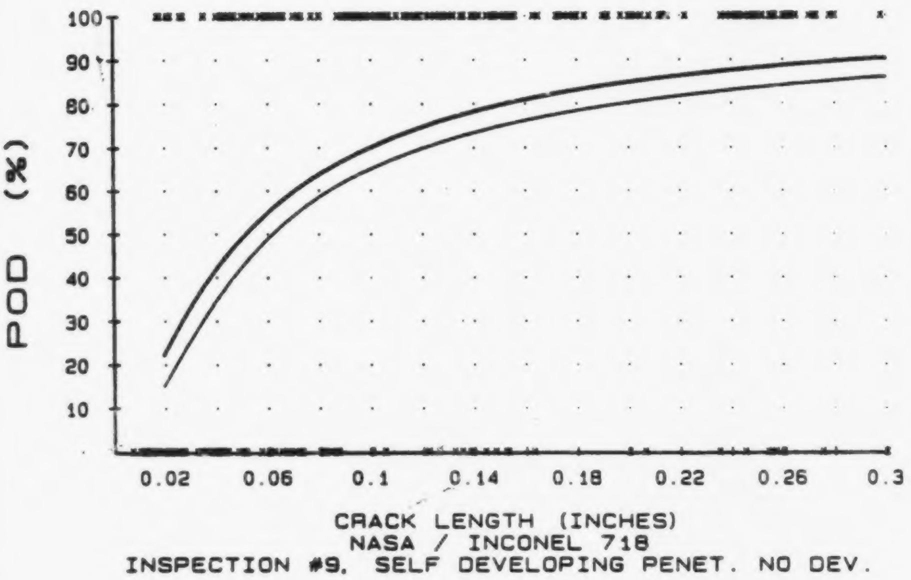
Inspection #8
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
20.1% Detection
23 False Calls

Maximum Likelihood Analysis



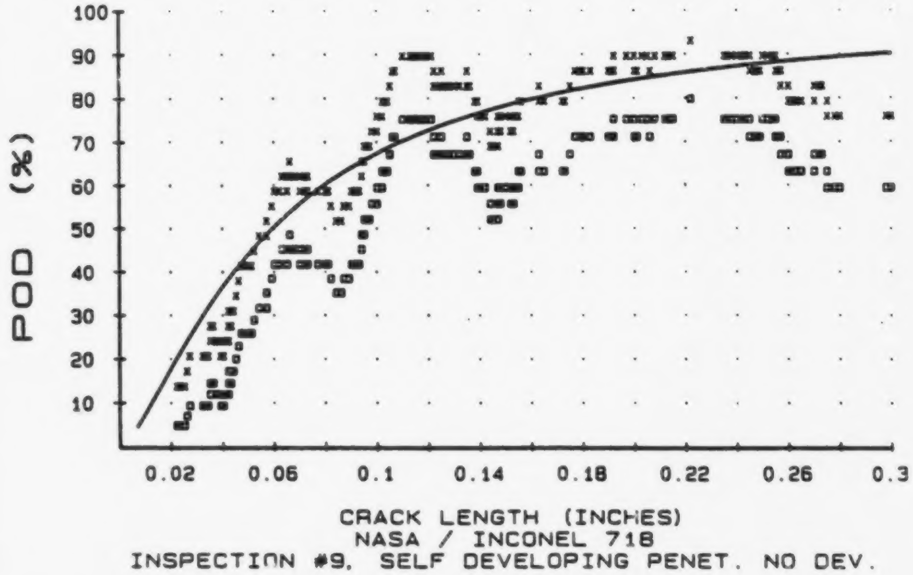
Moving Average Analysis

Figure B-8 Inspection #8 POD Curves



Inspection #9
Type I Penetrant
Self-Developing
Method A
Developer N/A
Inconel 718
110 Panels
281 Cracks
66.2% Detection
34 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure B-9 Inspection #9 POD Curves

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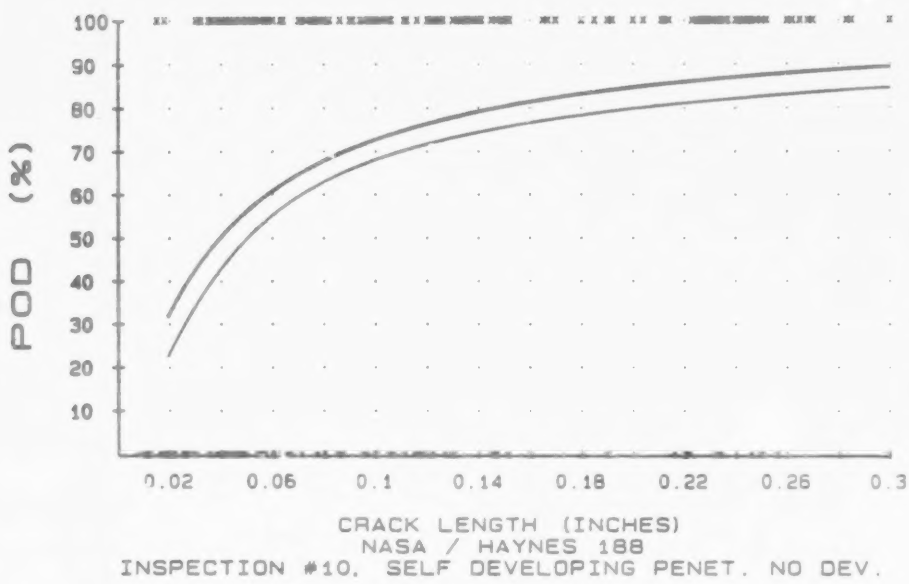
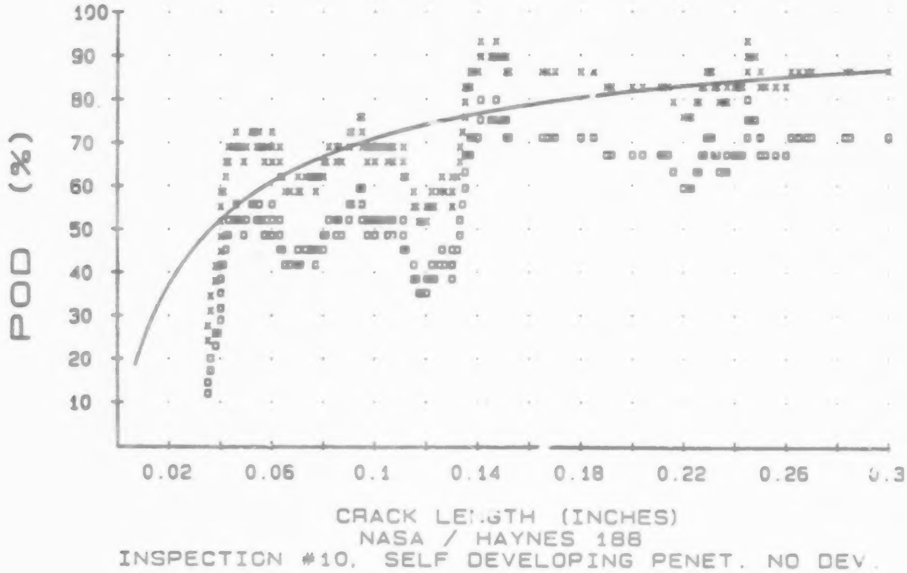


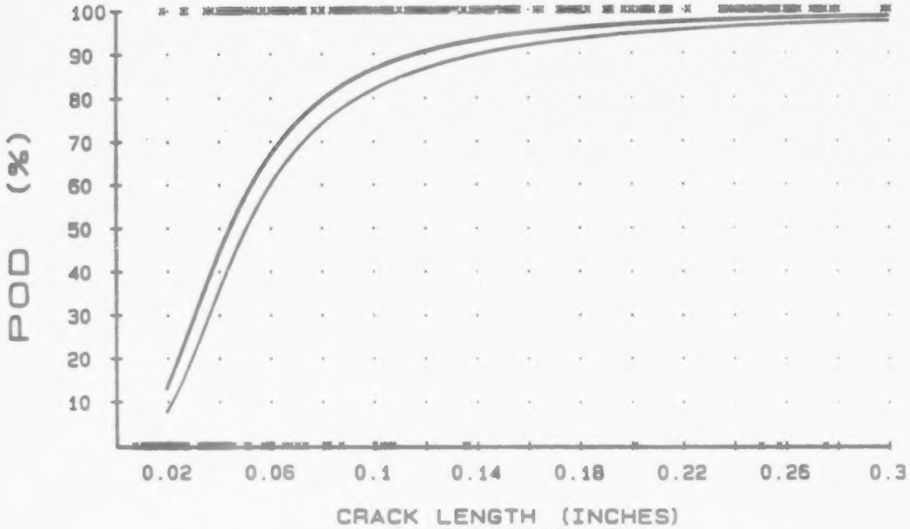
Inspection #10
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
69.7% Detection
91 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

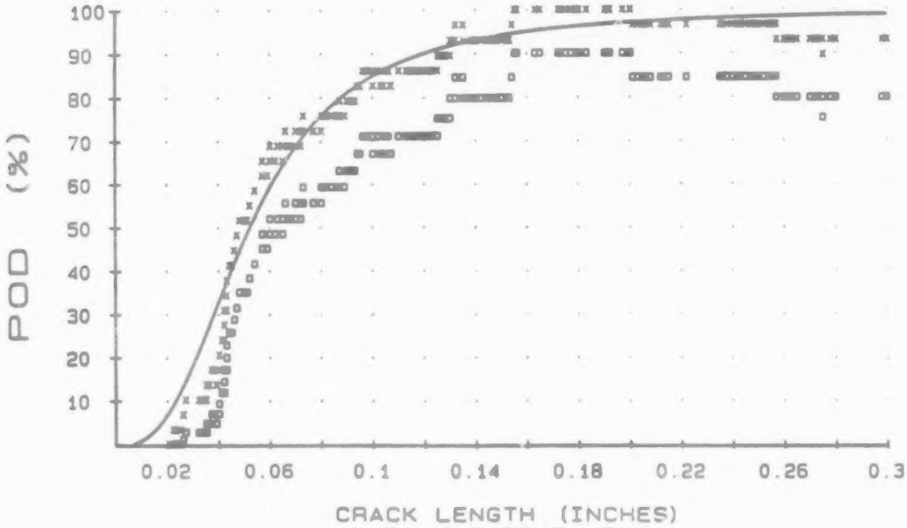
Figure B-10 Inspection #10 POD Curves



NASA / INCONEL 718
INSPECTION #11. SELF DEVELOPING PENET. NO DEV.

Inspection #11
Type I Penetrant
Self-Developing
Method A
Developer N/A
Inconel 718
110 Panels
281 Cracks
75.4% Detection
9 False Calls

Maximum Likelihood Analysis



NASA / INCONEL 718
INSPECTION #11. SELF DEVELOPING PENET. NO DEV.

Moving Average Analysis

Figure B-11 Inspection #11 POD Curves

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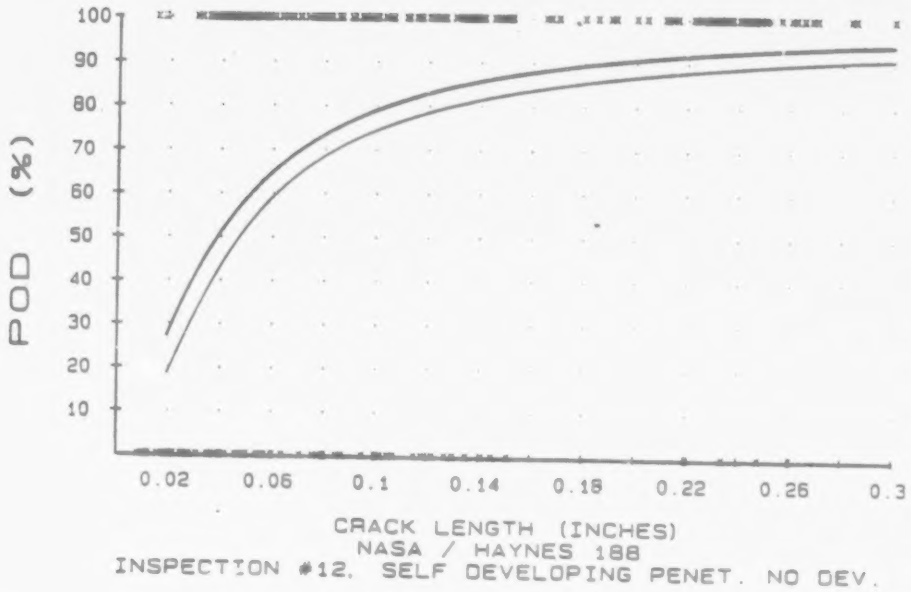
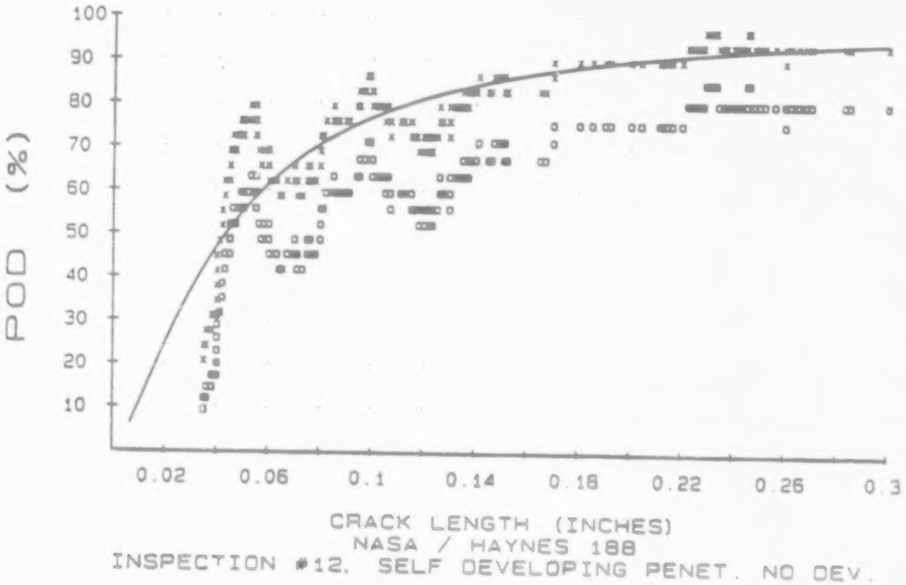


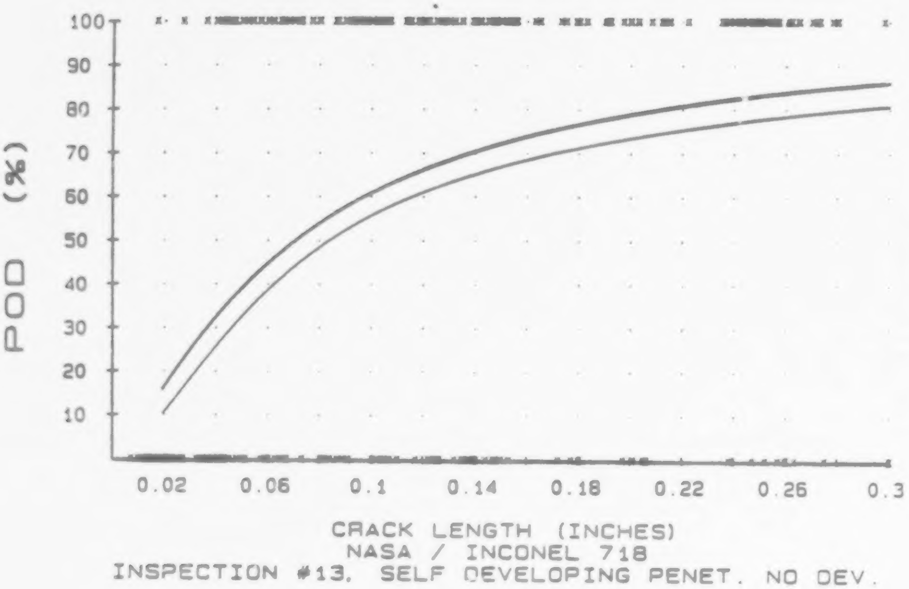
Inspection #12
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
73.9% Detection
20 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure B-12 Inspection #12 POD Curves



Inspection #13
Type I Penetrant
Self-Developing
Method A
Developer N/A
Inconel 718
110 Panels
281 Cracks
58.7% Detection
46 False Calls

Maximum Likelihood Analysis

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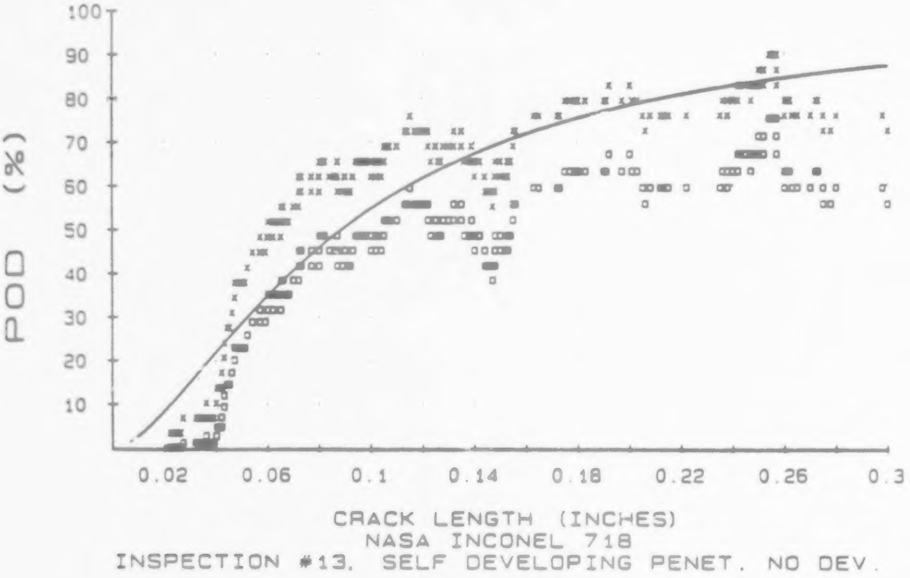

Moving Average Analysis

Figure B-13 Inspection #13 POD Curves

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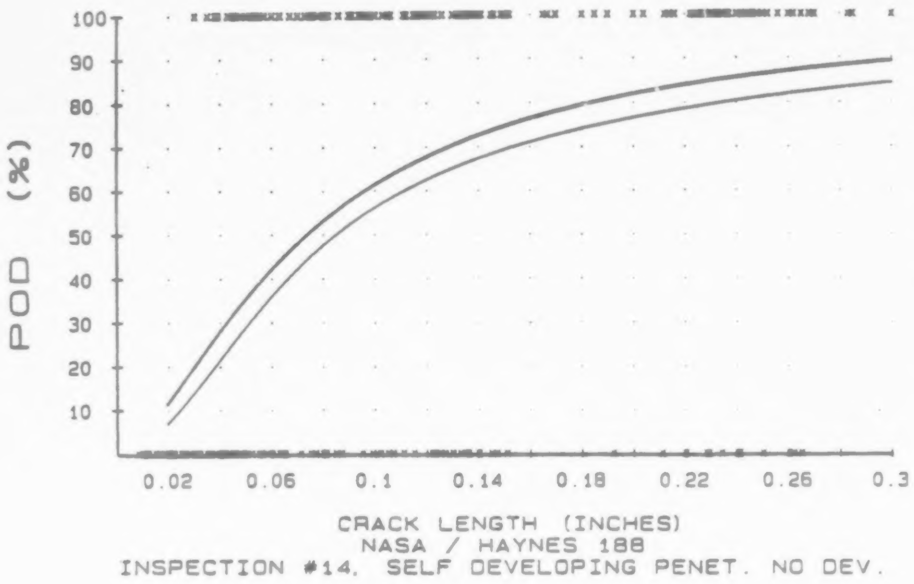


Inspection #14
Type I Penetrant
Self-Developing
Method A
Developer N/A
Haynes 188
102 Panels
284 Cracks
58.8% Detection
33 False Calls

Maximum Likelihood Analysis

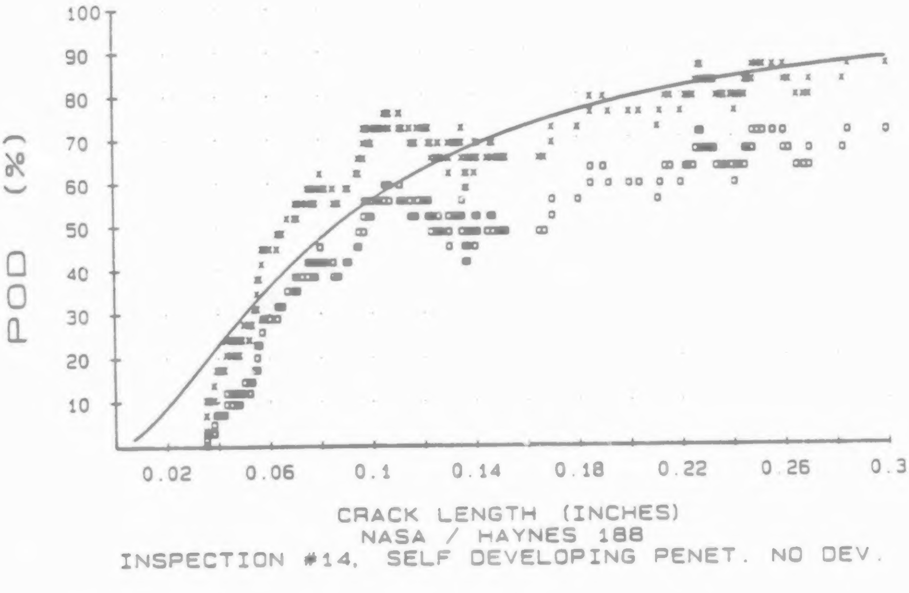
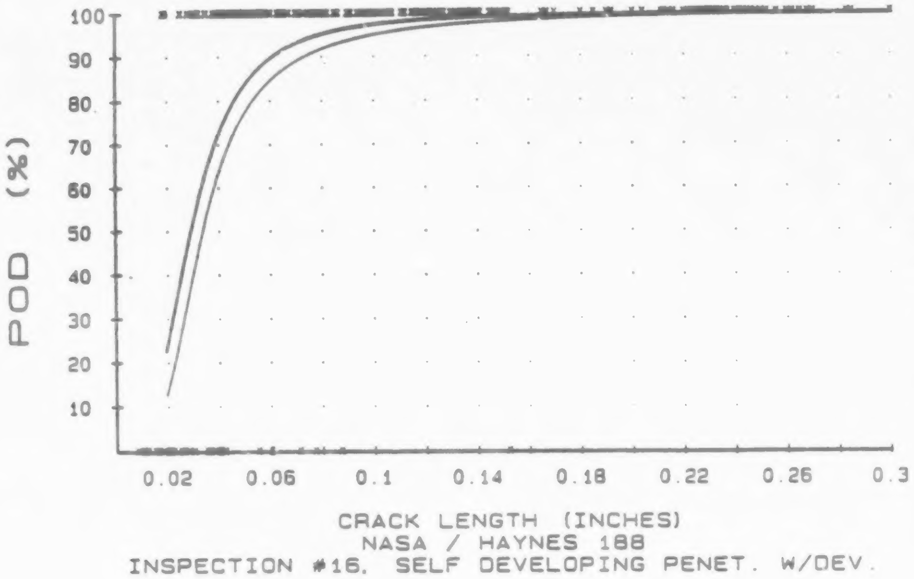
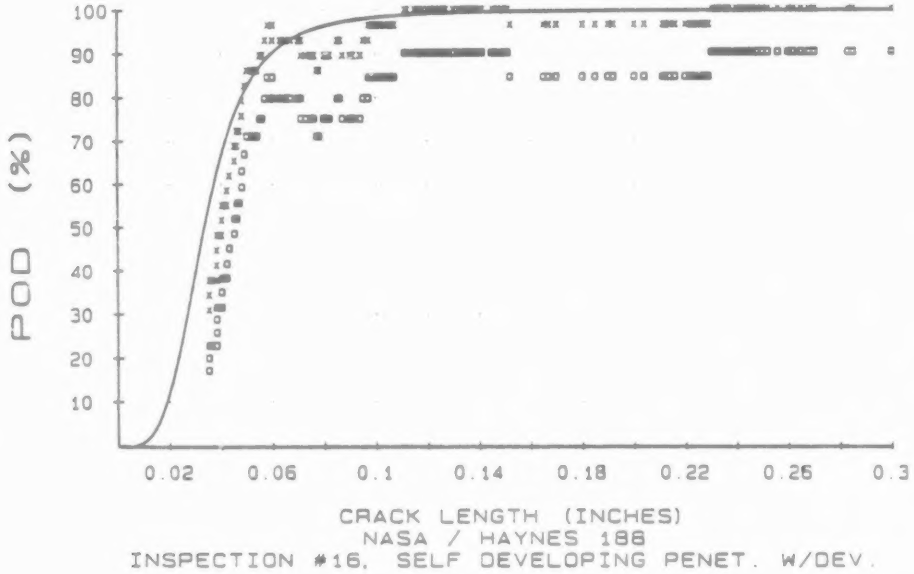


Figure B-14 Inspection #14 POD Curves



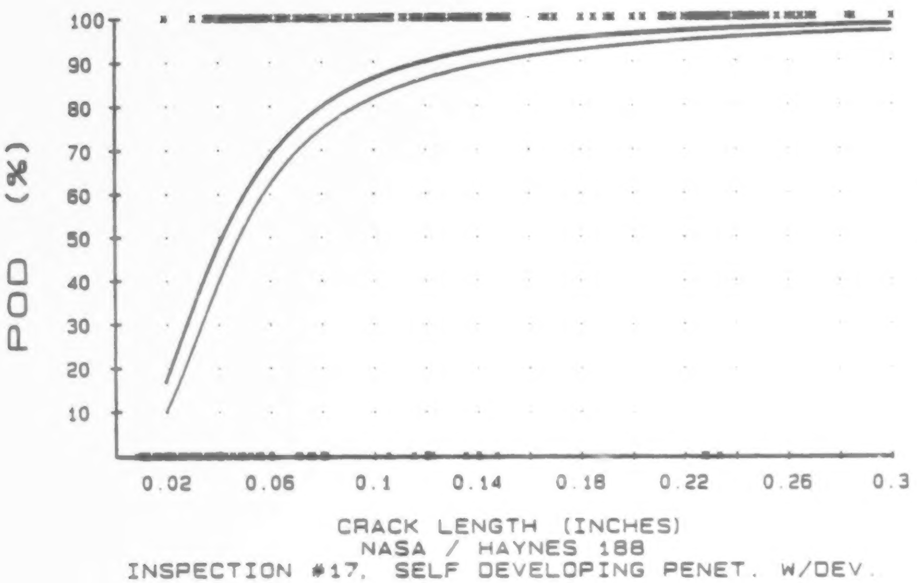
Inspection #16
Type I Penetrant
Self-Developing
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
87.3% Detection
5 False Calls

Maximum Likelihood Analysis



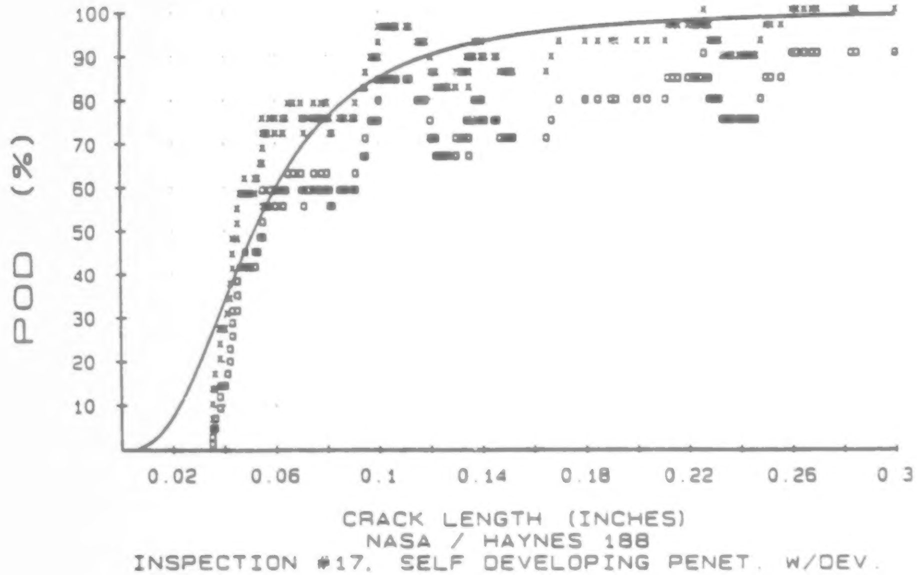
Moving Average Analysis

Figure B-16 Inspection #16 POD Curves



Inspection #17
Type I Penetrant
Self-Developing
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
77.1% Detection
16 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure B-17 Inspection #17 POD Curves

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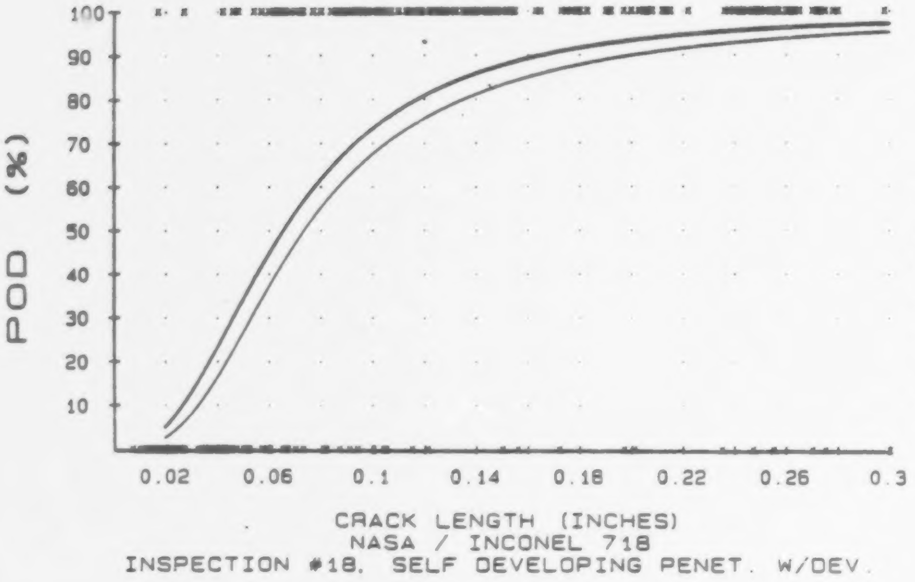
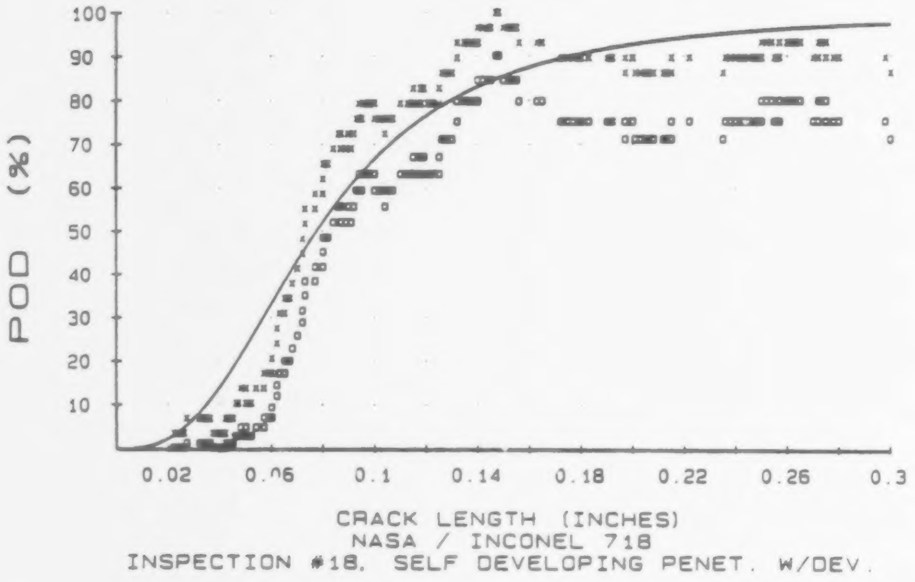


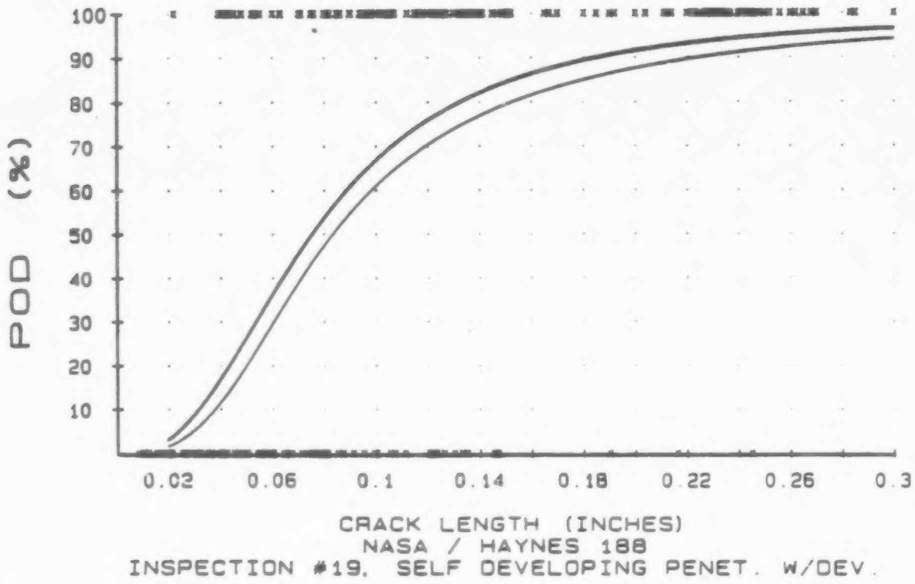
Inspection #18
Type I Penetrant
Self-Developing
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
65.4% Detection
16 False Calls

Maximum Likelihood Analysis



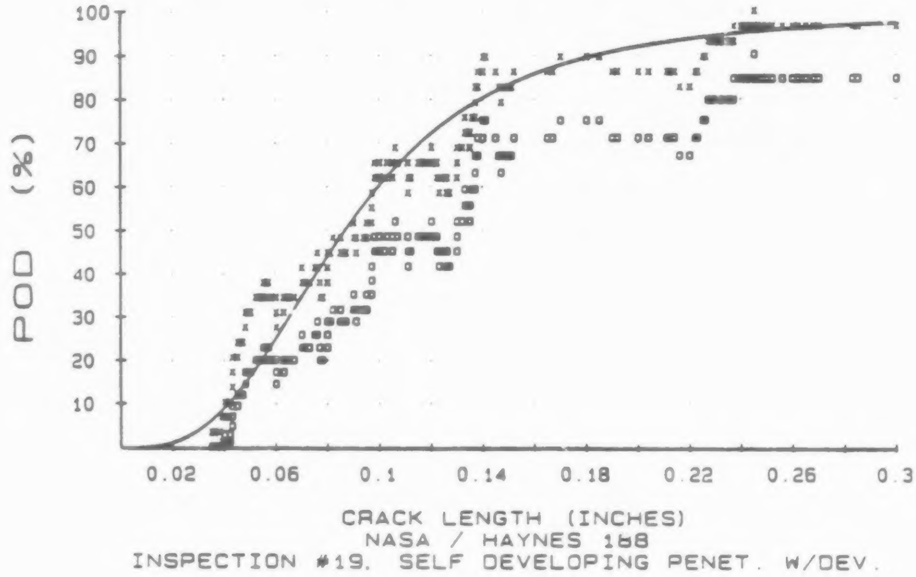
Moving Average Analysis

Figure B-18 Inspection #18 POD Curves



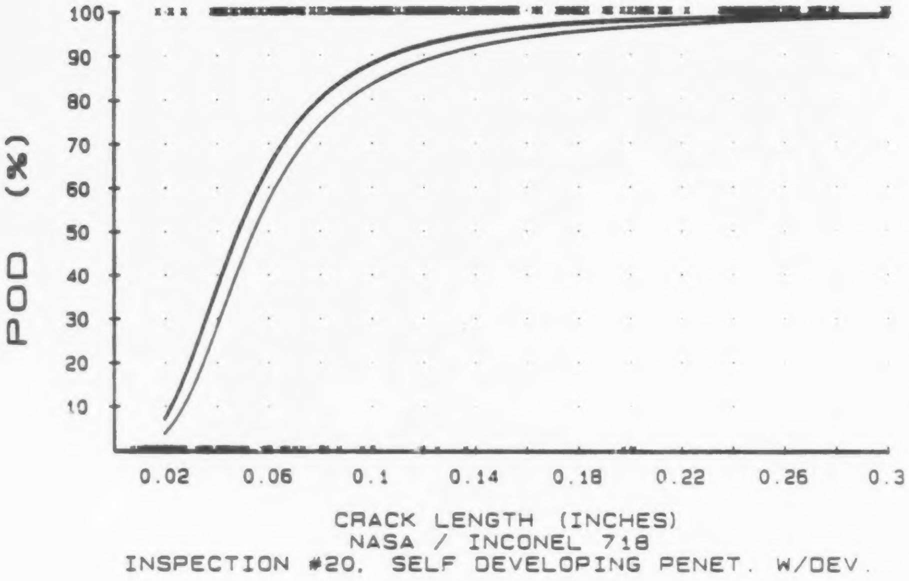
Inspection #19
Type I Penetrant
Self-Developing
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
60.9% Detection
49 False Calls

Maximum Likelihood Analysis



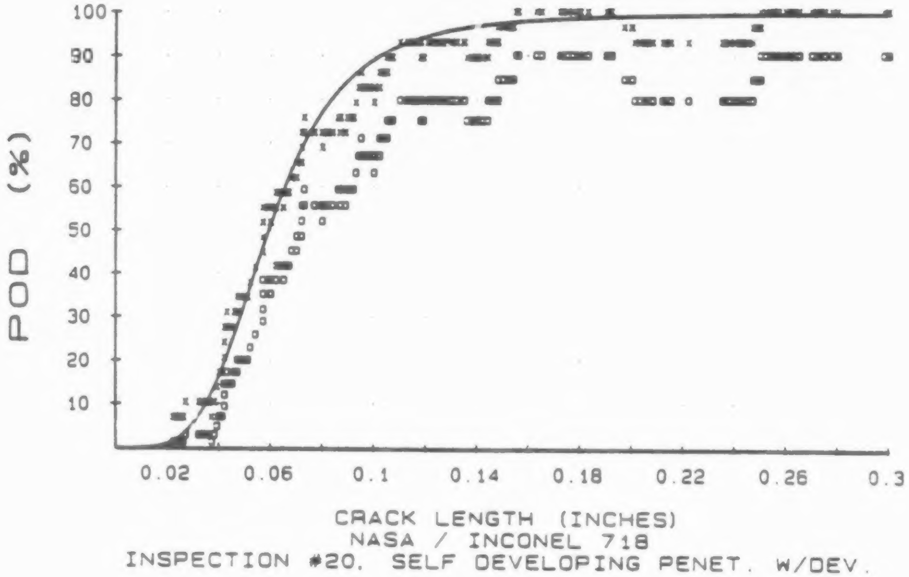
Moving Average Analysis

Figure B-19 Inspection #19 POD Curves



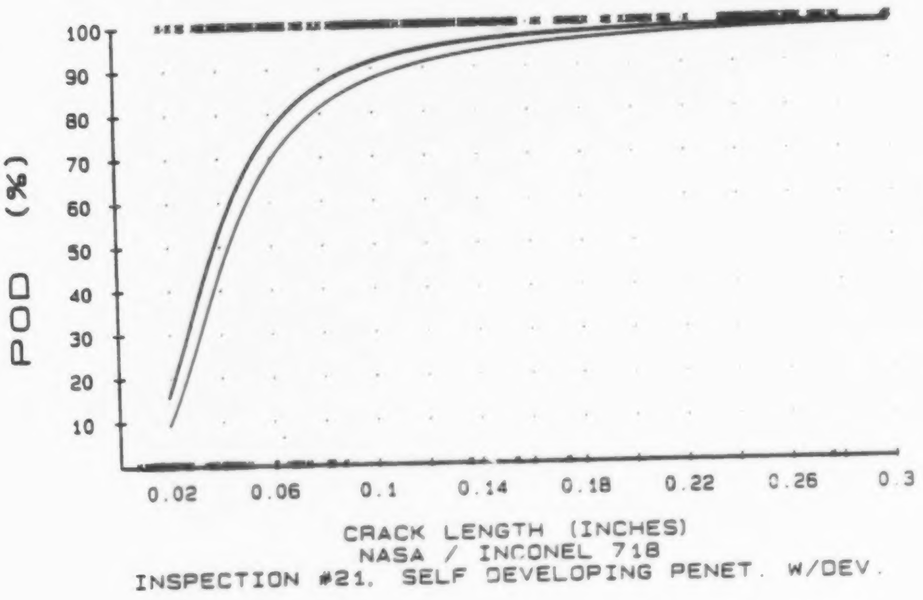
Inspection #20
Type I Penetrant
Self-Developing
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
74.7% Detection
18 False Calls

Maximum Likelihood Analysis



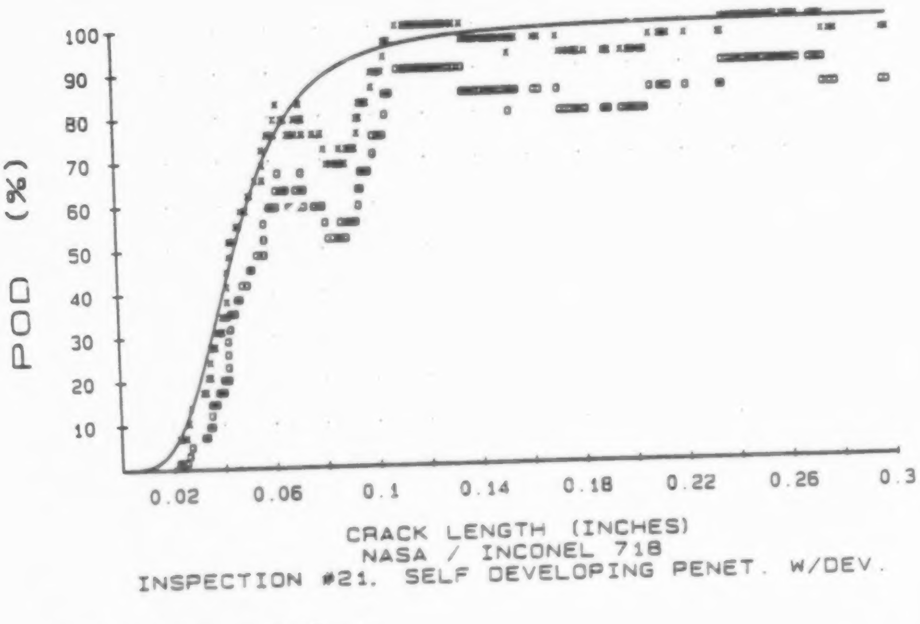
Moving Average Analysis

Figure B-20 Inspection #20 POD Curves



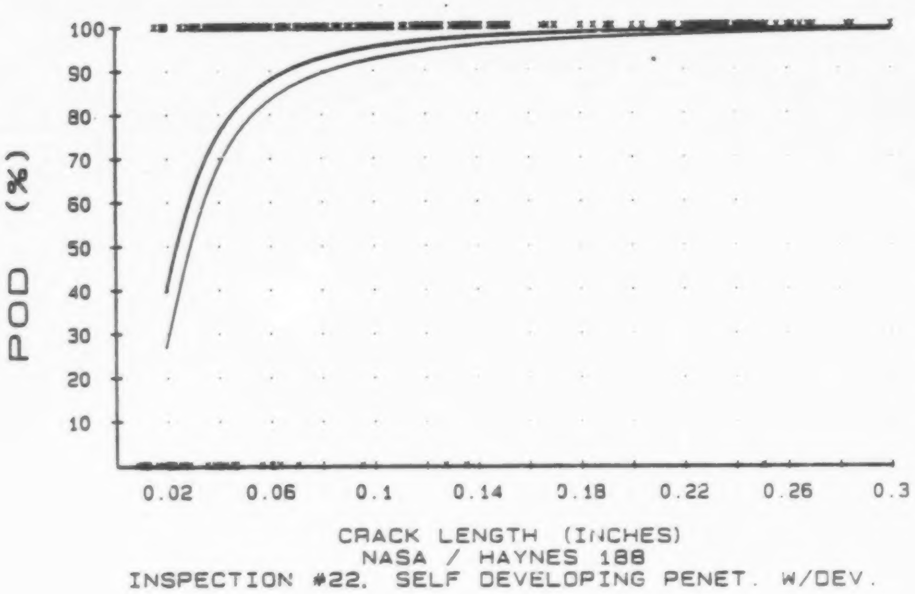
Inspection #21
Type I Penetrant
Self-Developing
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
80.4% Detection
34 False Calls

Maximum Likelihood Analysis



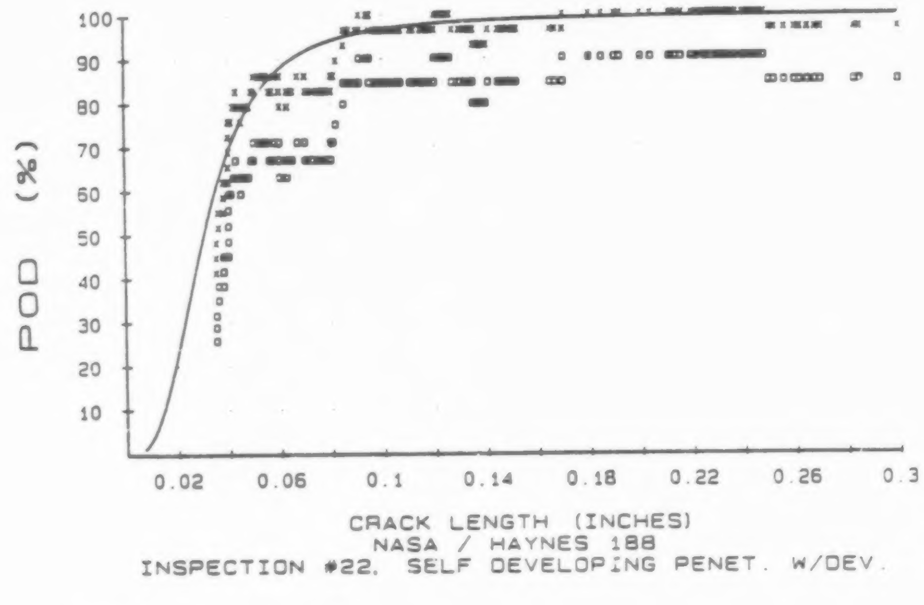
Moving Average Analysis

Figure B-21 Inspection #21 POD Curves



Inspection #22
Type I Penetrant
Self-Developing
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
88.3% Detection
27 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure B-22 Inspection #22 POD Curves

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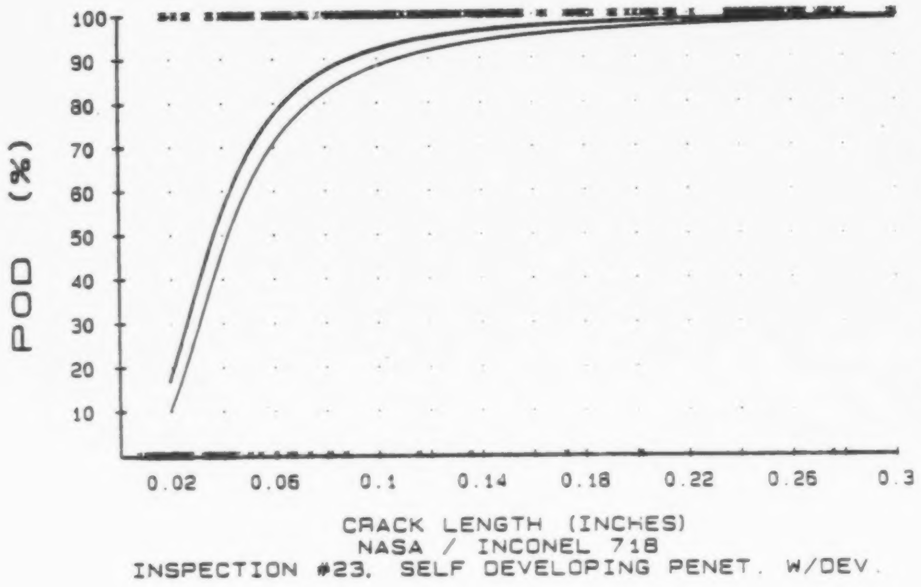
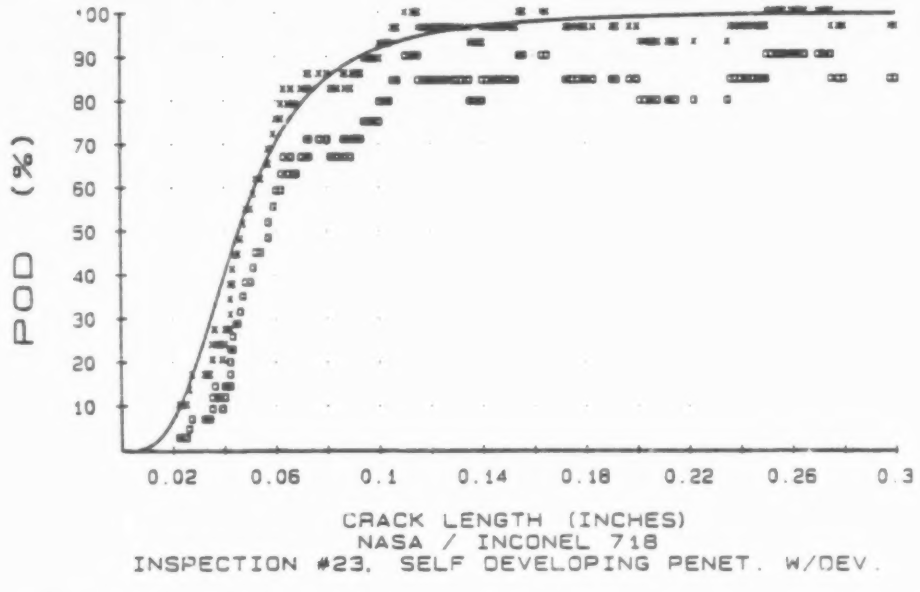


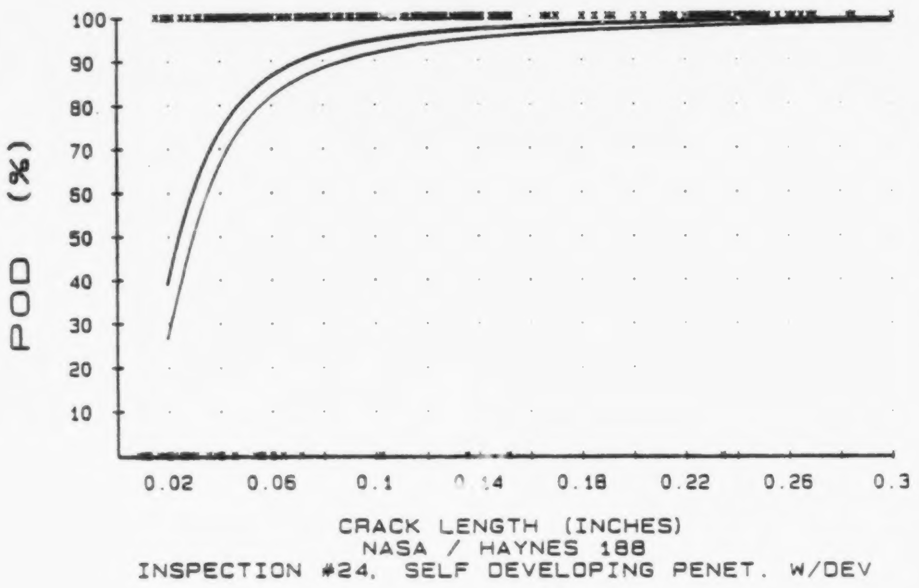
Inspection #23
Type I Penetrant
Self-Developing
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
80.1% Detection
3 False Calls

Maximum Likelihood Analysis



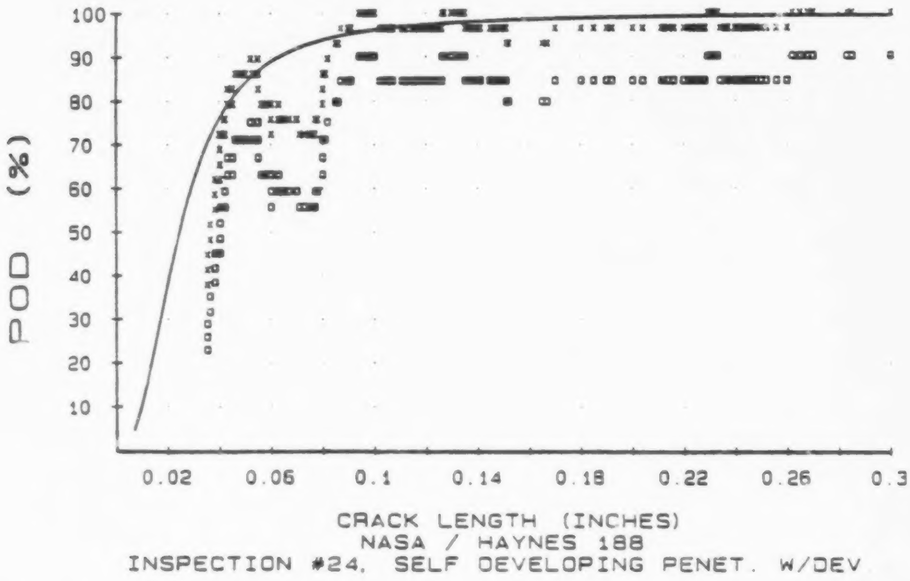
Moving Average Analysis

Figure B-23 Inspection #23 POD Curves



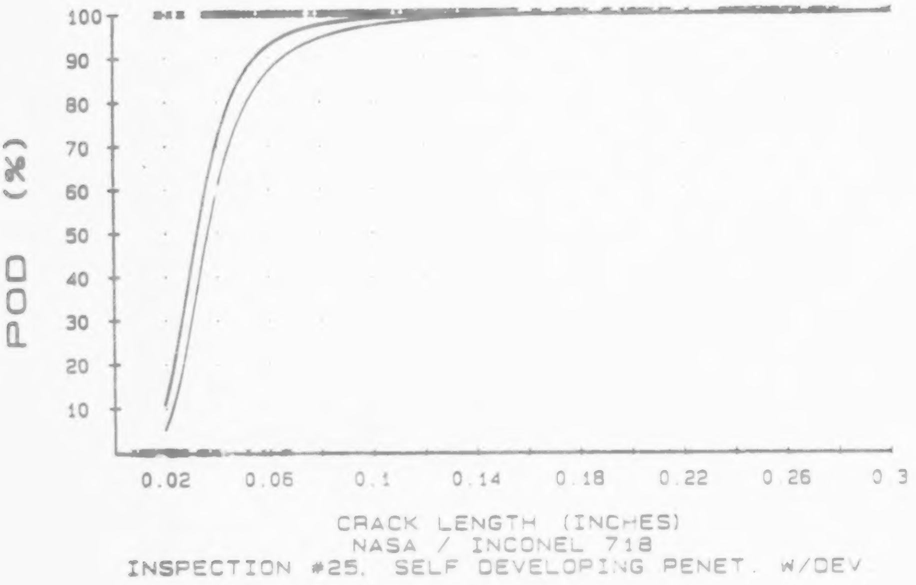
Inspection #24
Type I Penetrant
Self-Developing
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
87.7% Detection
5 False Calls

Maximum Likelihood Analysis



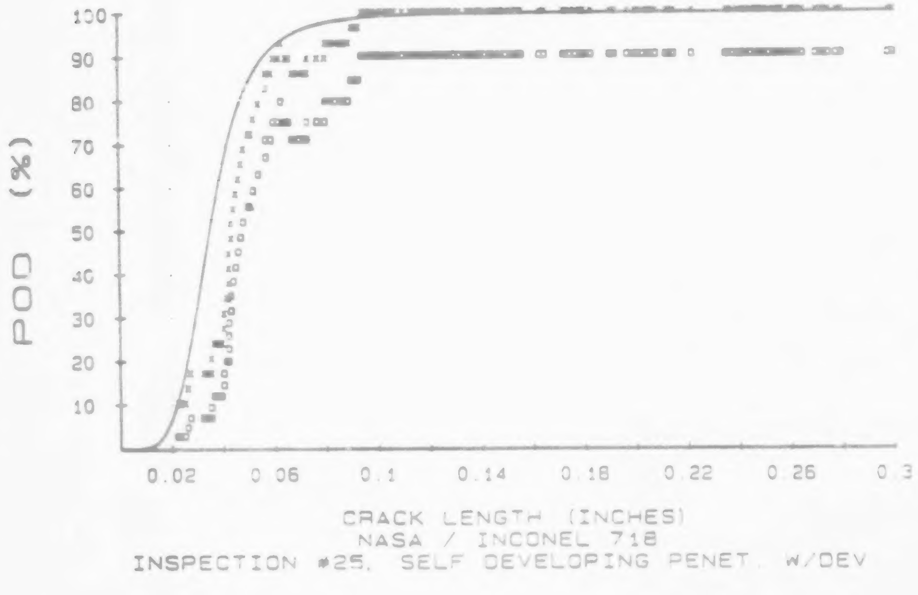
Moving Average Analysis

Figure B-24 Inspection #24 POD Curves



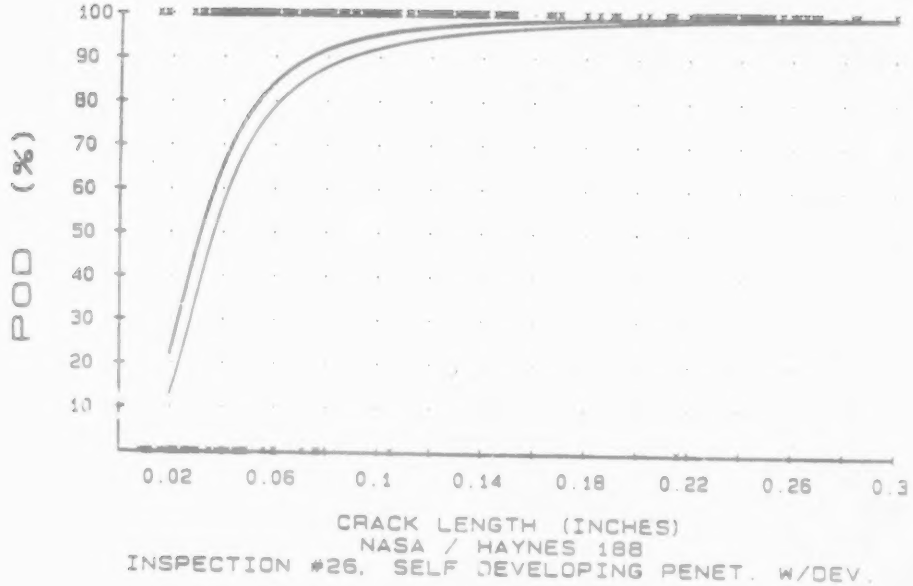
Inspection #25
Type I Penetrant
Self-Developing
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
84.7% Detection
27 False Calls

Maximum Likelihood Analysis



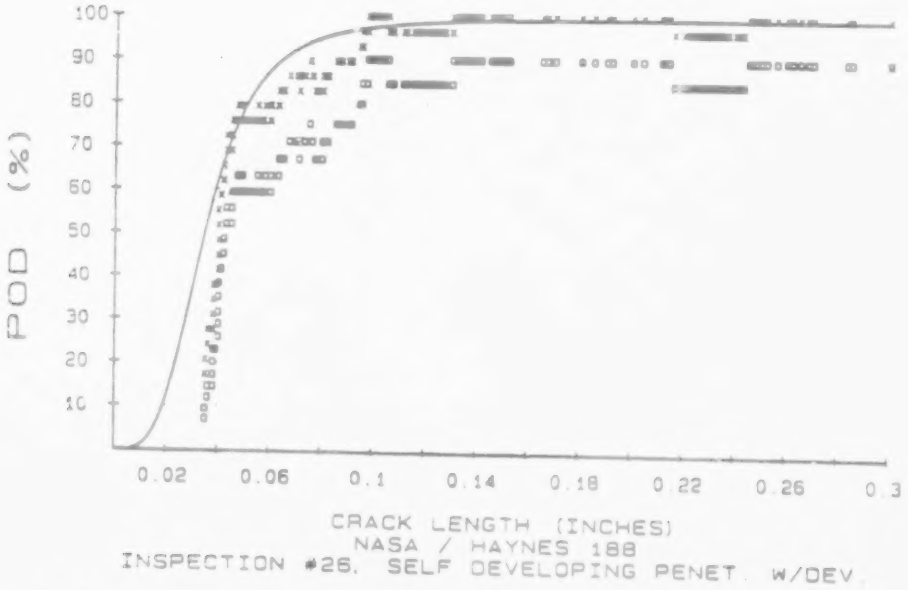
Moving Average Analysis

Figure B-25 Inspection #25 POD Curves



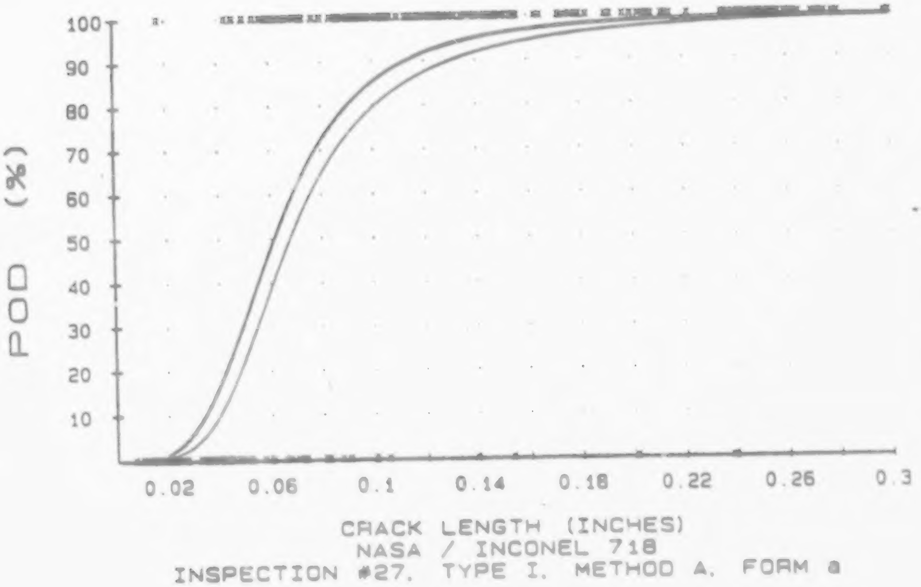
Inspection #26
Type I Penetrant
Self-Developing
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
85.2% Detection
4 False Calls

Maximum Likelihood Analysis



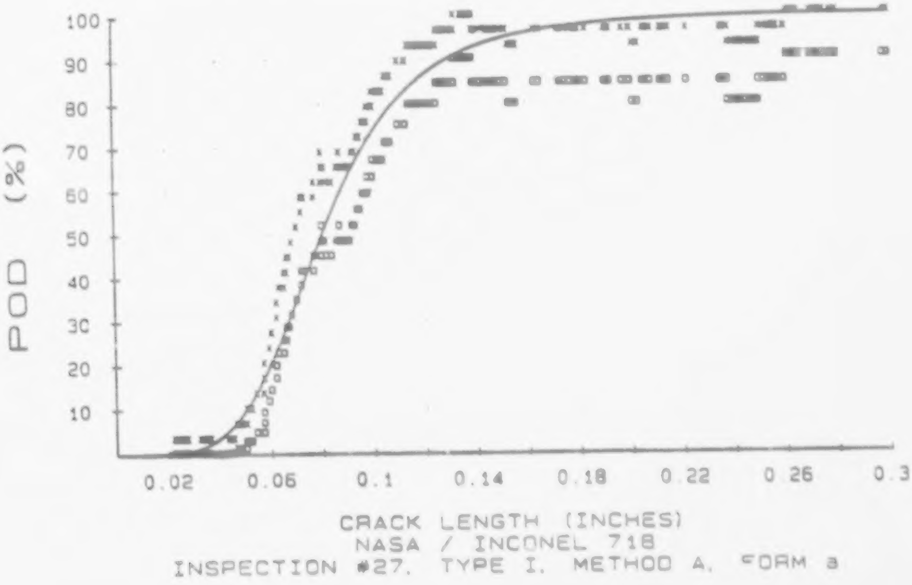
Moving Average Analysis

Figure B-26 Inspection #26 POD Curves



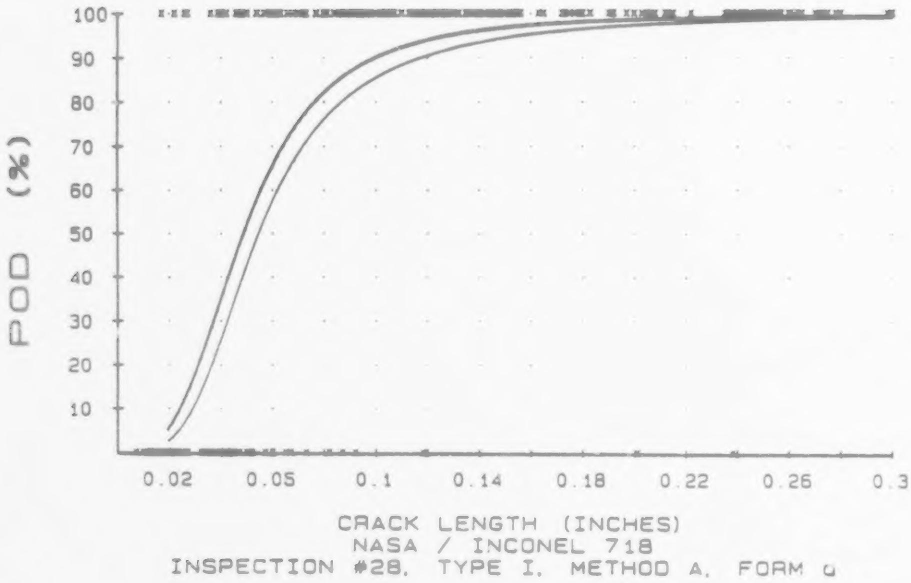
Inspection #27
Type I Penetrant
Sensitivity 2
Method A
Developer Form a
Inconel 718
110 Panels
281 Cracks
69.0% Detection
8 False Calls

Maximum Likelihood Analysis



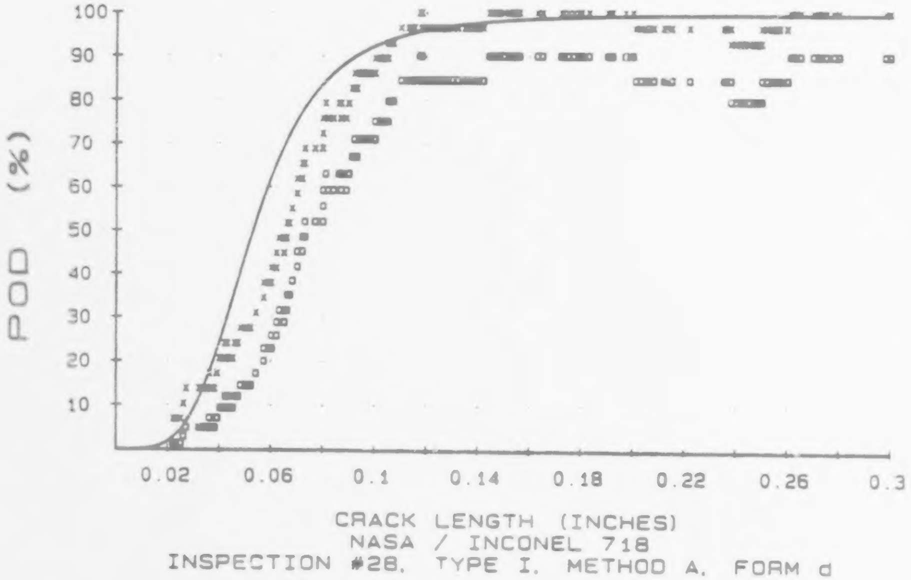
Moving Average Analysis

Figure B-27 Inspection #27 POD Curves



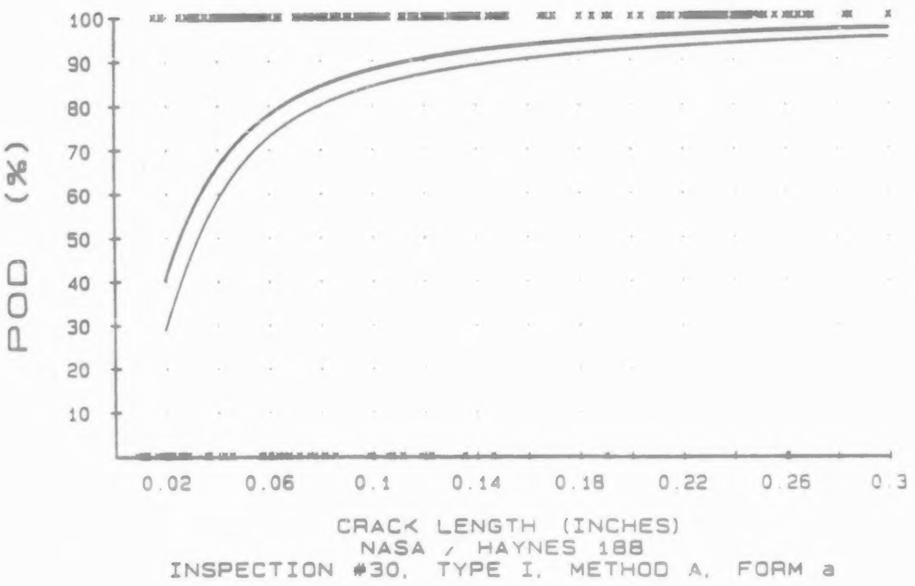
Inspection 28
Type I Penetrant
Sensitivity 2
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
75.1% Detection
10 False Calls

Maximum Likelihood Analysis



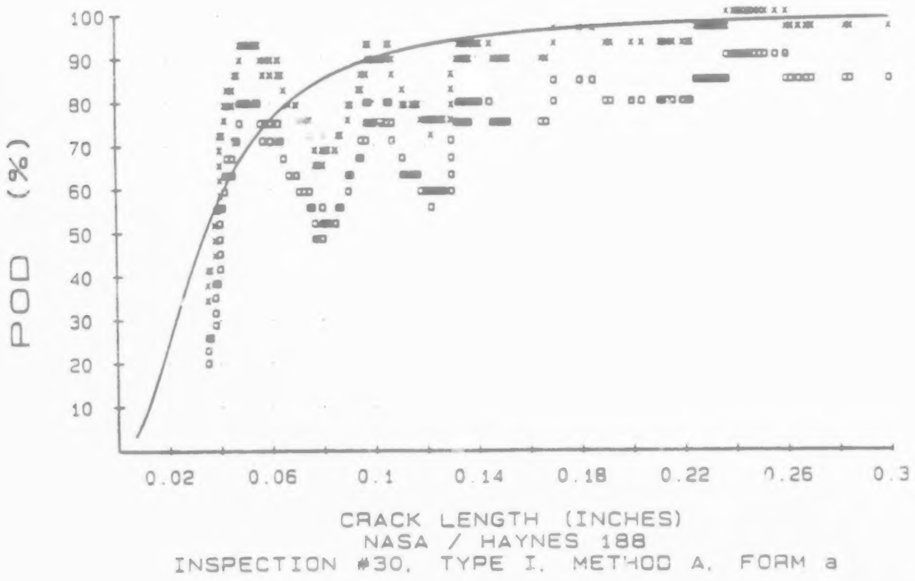
Moving Average Analysis

Figure B-28 Inspection #28 POD Curves



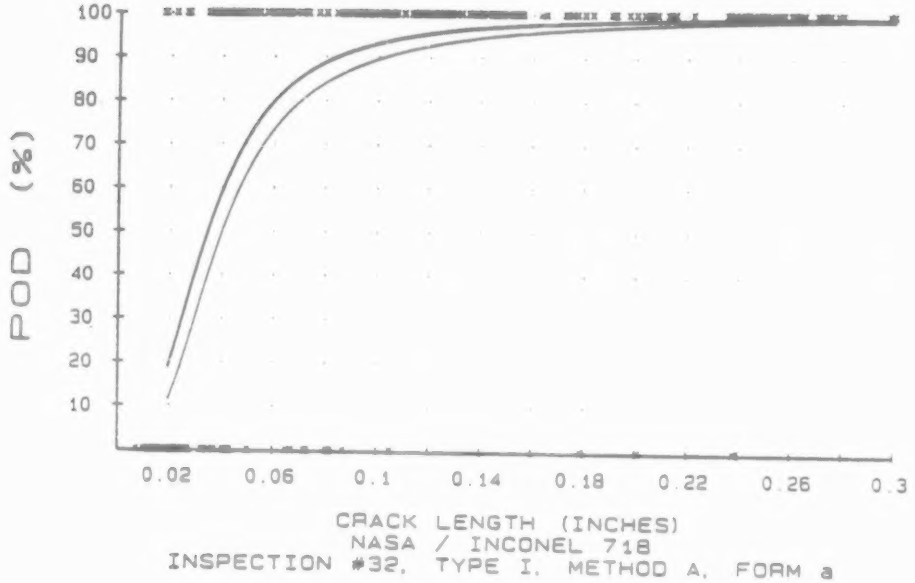
Inspection #30
Type I Penetrant
Sensitivity 3
Method A
Developer Form a
Haynes 188
102 Panels
284 Cracks
82.7% Detection
26 False Calls

Maximum Likelihood Analysis



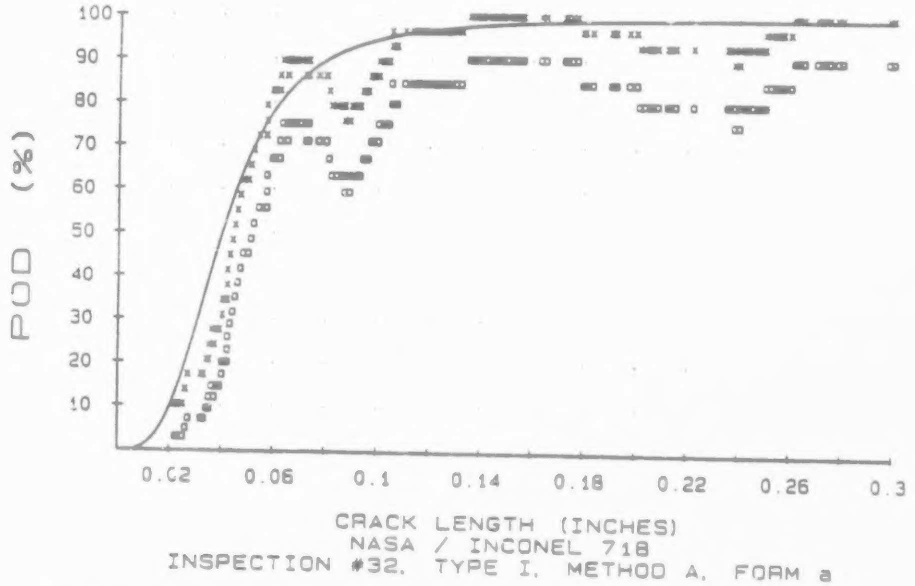
Moving Average Analysis

Figure B-30 Inspection #30 POD Curves



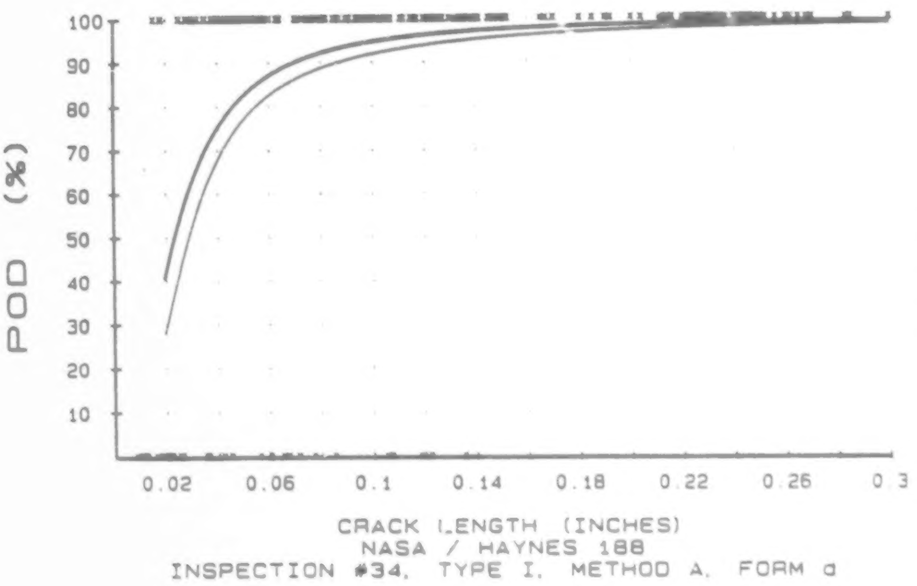
Inspection #32
Type I Penetrant
Sensitivity 3
Method A
Developer Form a
Inconel 718
110 Panels
281 Cracks
81.1% Detection
3 False Calls

Maximum Likelihood Analysis



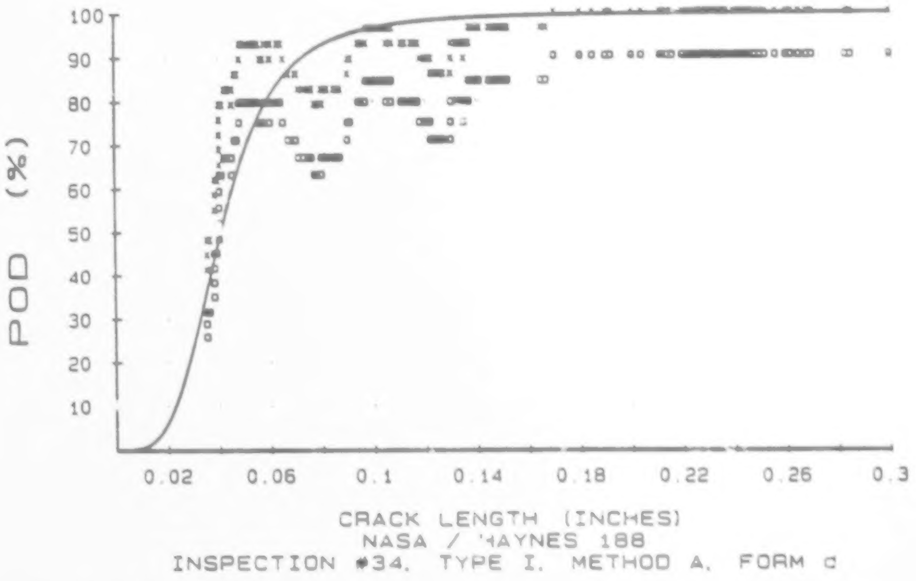
Moving Average Analysis

Figure B-32 Inspection #32 POD Curves



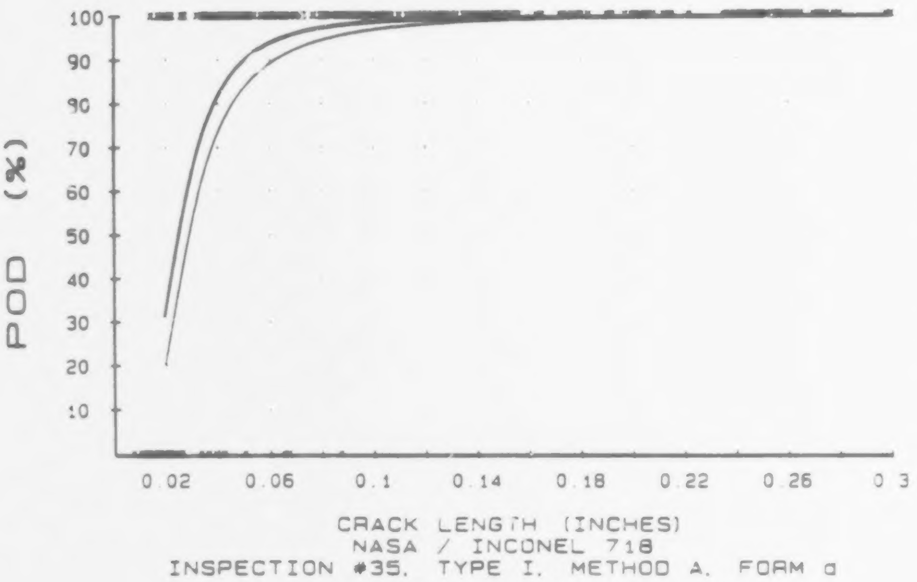
Inspection #34
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
88.0% Detection
41 False Calls

Maximum Likelihood Analysis



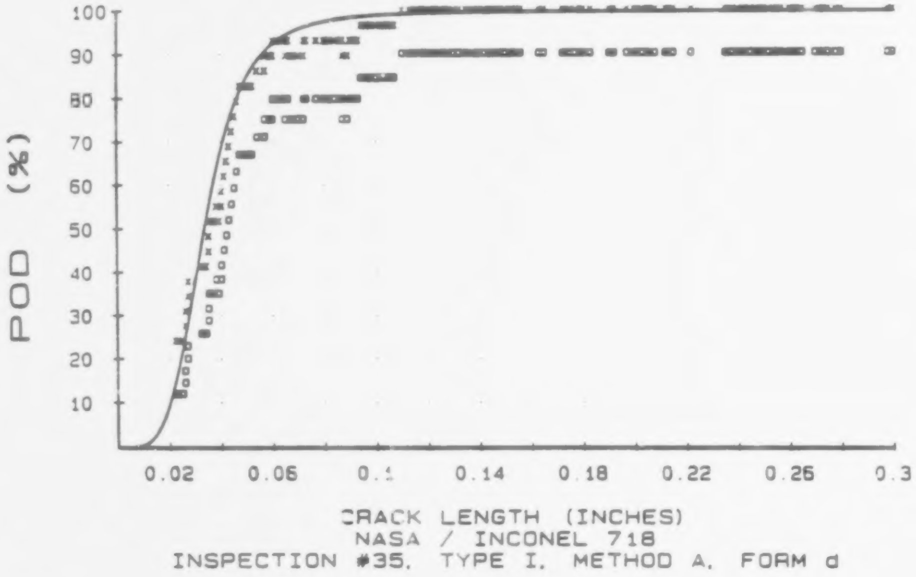
Moving Average Analysis

Figure B-34 Inspection #34 POD Curves



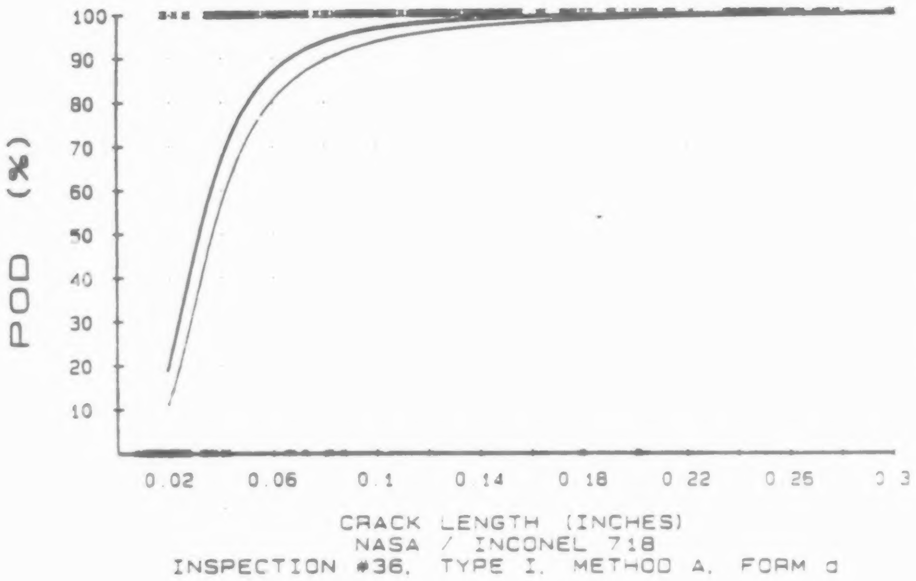
Inspection #35
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
87.9% Detection
2 False Calls

Maximum Likelihood Analysis



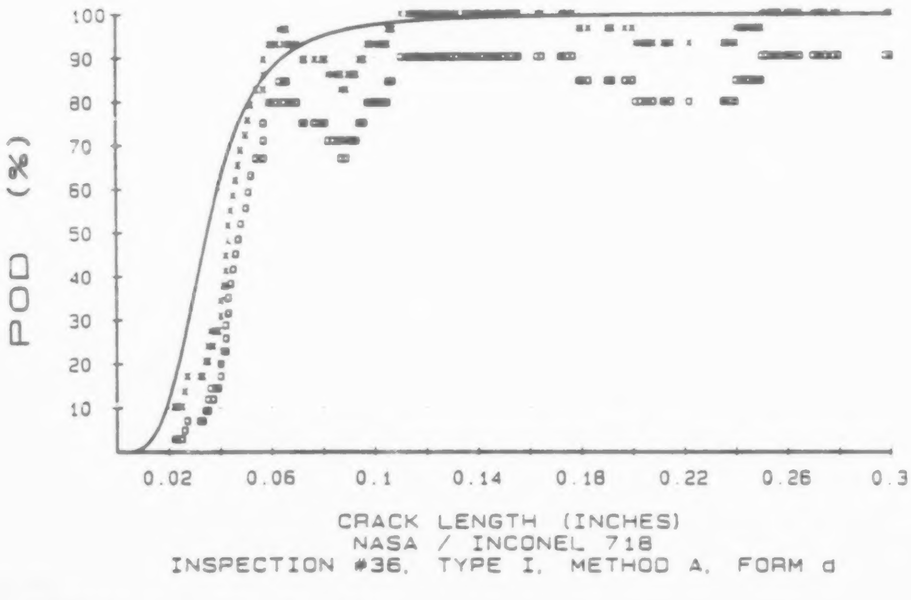
Moving Average Analysis

Figure B-35 Inspection #35 POD Curves



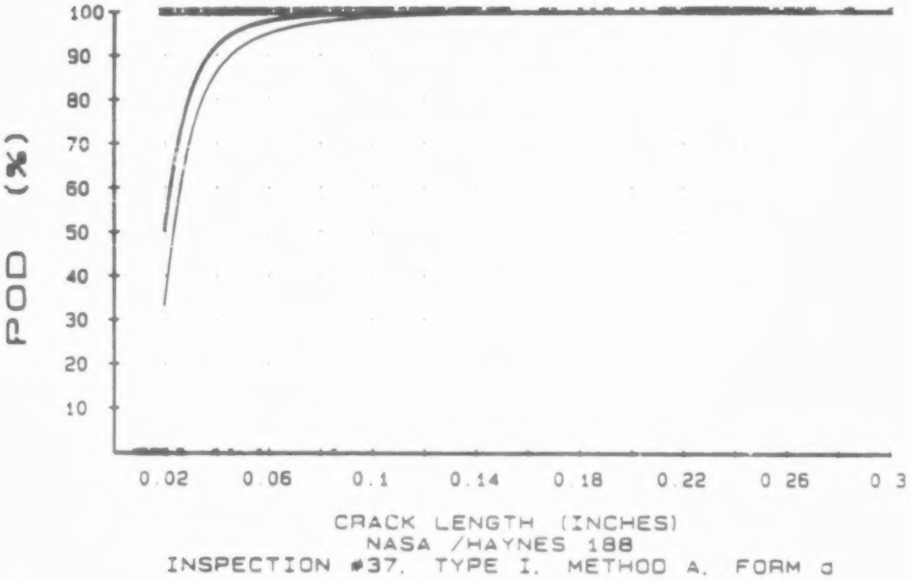
Inspection #36
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
83.6% Detection
6 False Calls

Maximum Likelihood Analysis



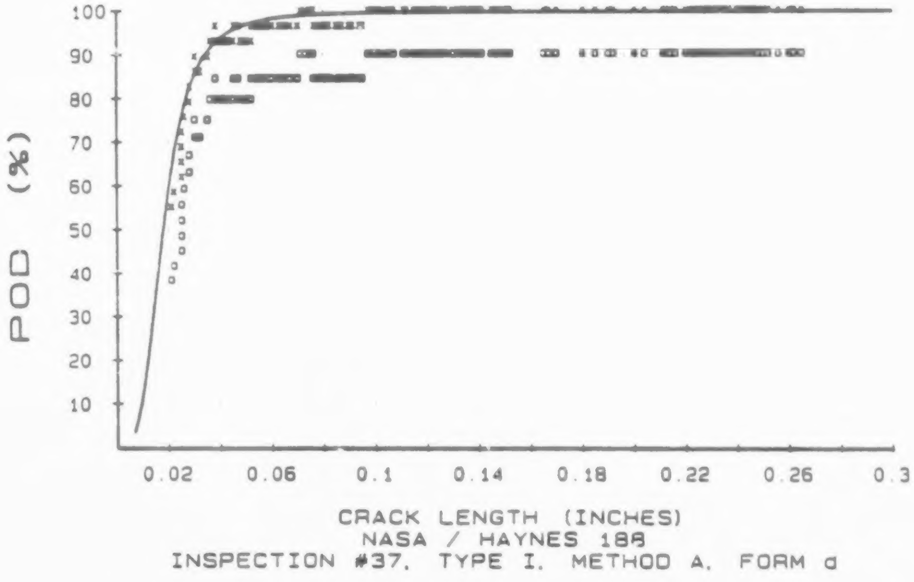
Moving Average Analysis

Figure B-36 Inspection #36 POD Curves



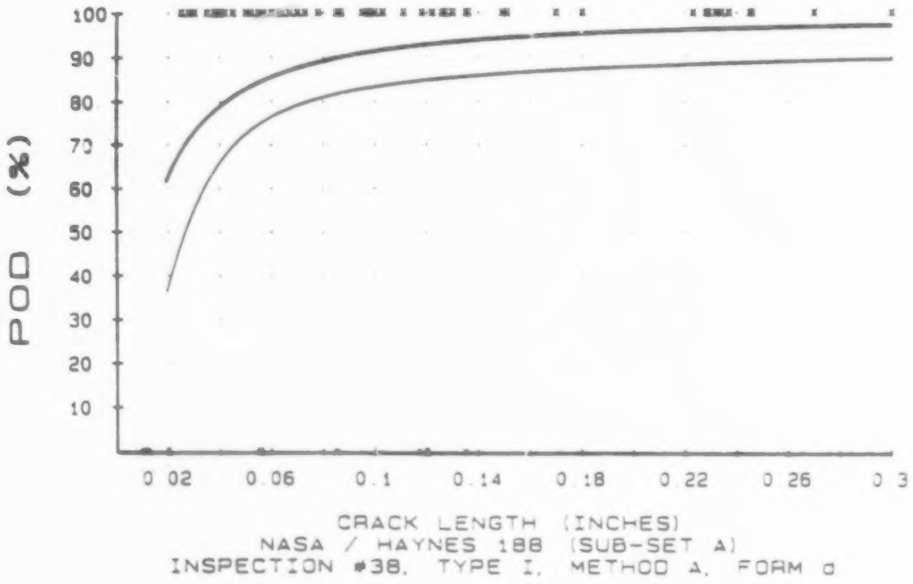
Inspection #37
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
Haynes 188
102 Panels
284 Cracks
94.0% Detection
4 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

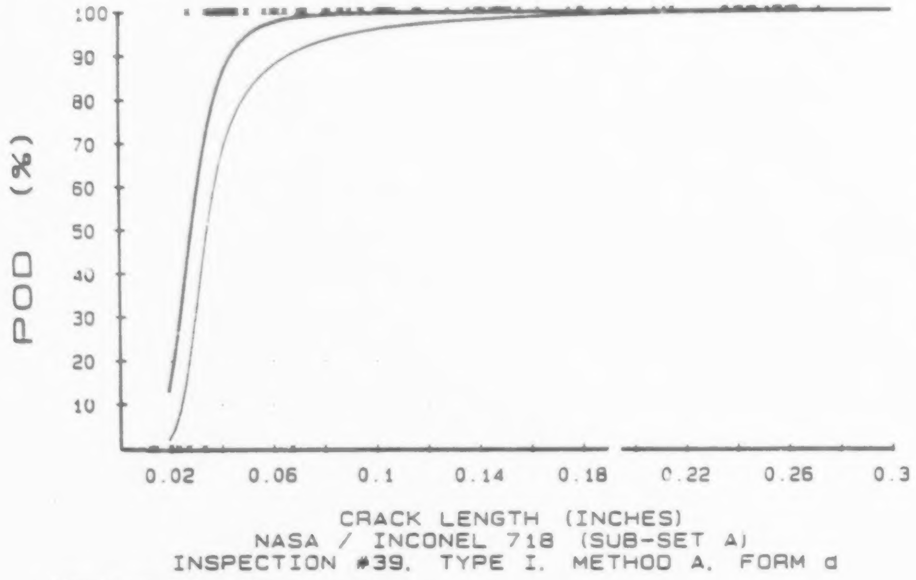
Figure B-37 Inspection #37 POD Curves



Inspection #38
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
H188 Subset A
23 Panels
72 Cracks
87.5% Detection
6 False Calls

Maximum Likelihood Analysis

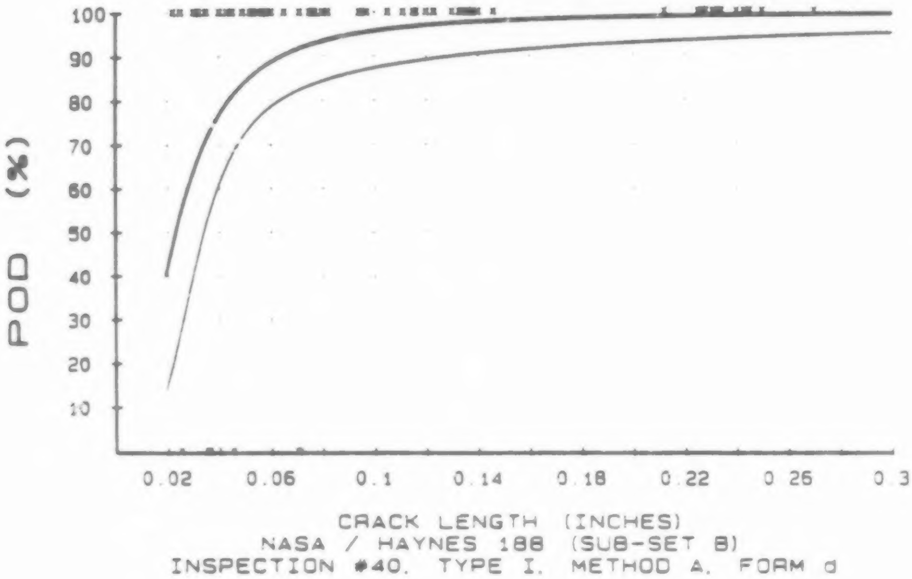
Figure B-38 Inspection #38 POD Curve



Inspection #39
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
I718 Subset A
24 Panels
90 Cracks
92.2% Detection
6 False Calls

Maximum Likelihood Analysis

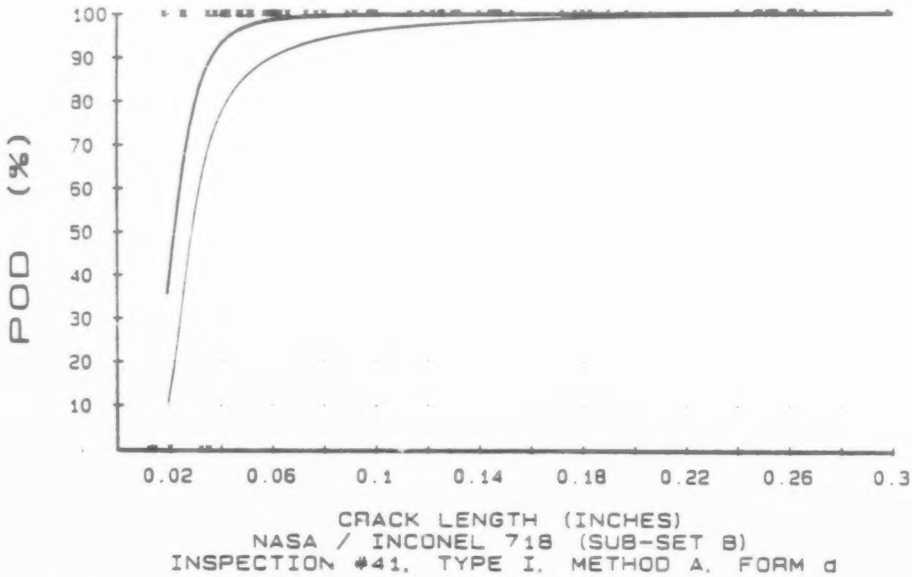
Figure B-39 Inspection #39 POD Curve



Inspection #40
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
H188 Subset B
21 Panels
68 Cracks
89.7% Detection
4 False Calls

Maximum Likelihood Analysis

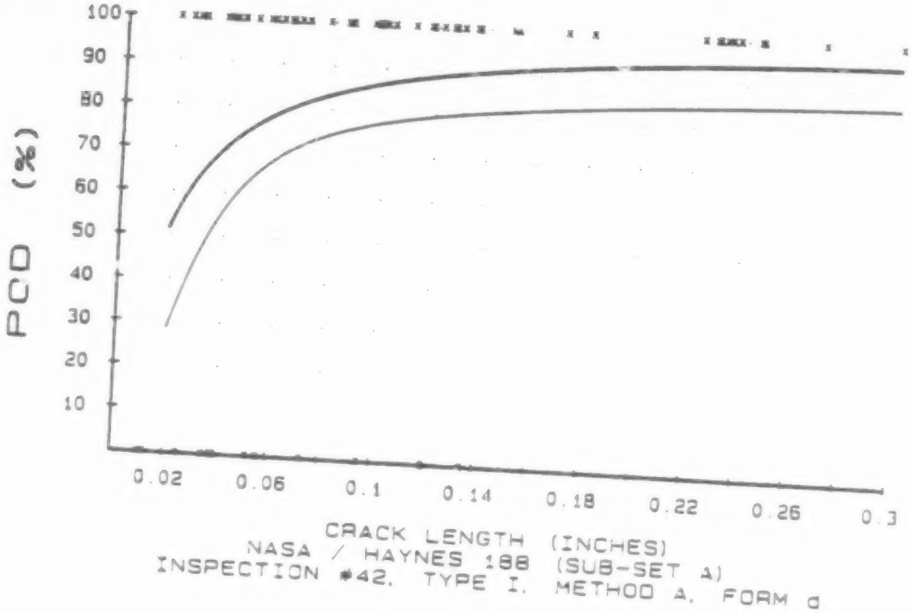
Figure B-40 Inspection #40 POD Curve



Inspection #41
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
I718 Subset B
24 Panels
75 Cracks
93.3% Detection
3 False Calls

Maximum Likelihood Analysis

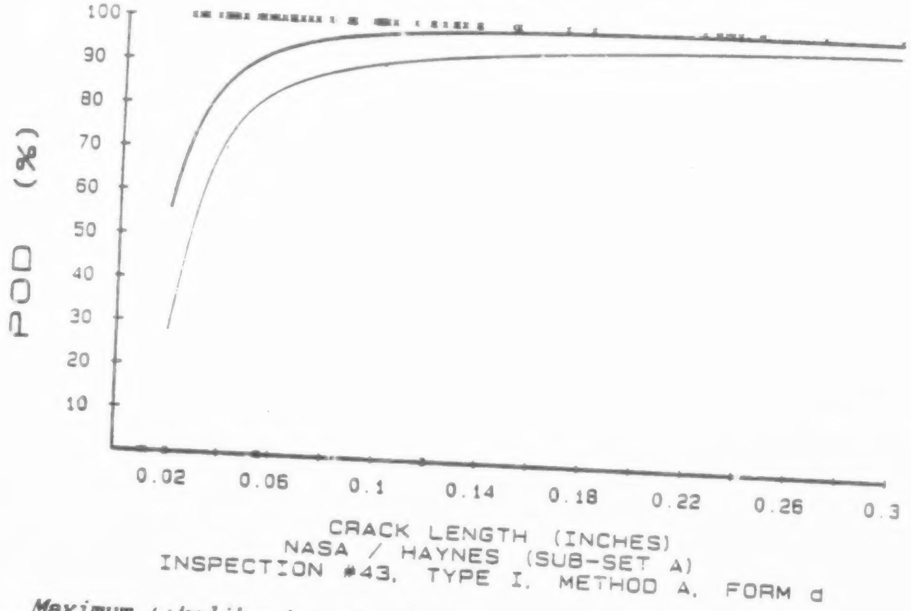
Figure B-41 Inspection #41 POD Curve



Inspection #42
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
H188 Subset A
23 Panels
72 Cracks
81.9% Detection
2 False Calls

Maximum Likelihood Analysis

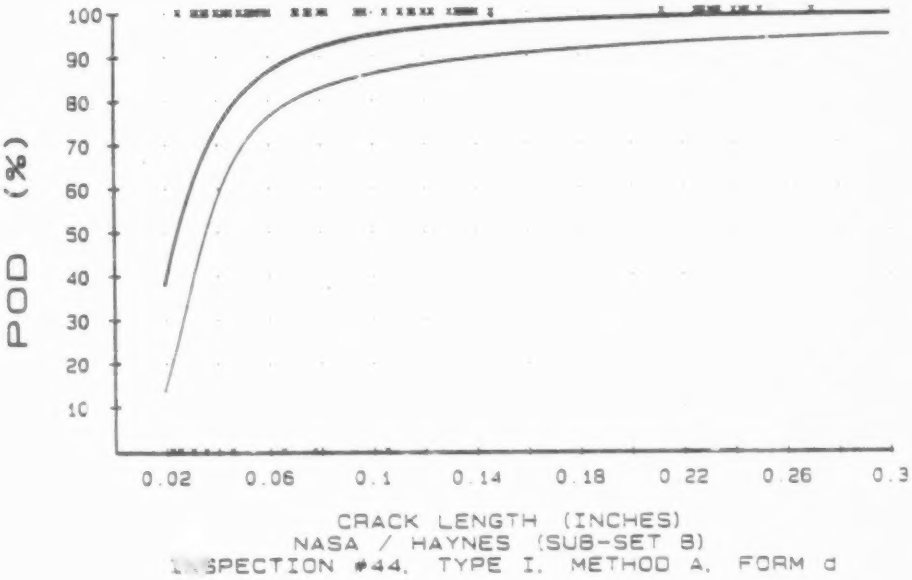
Figure B-42 Inspection #42 POD Curve



Inspection #43
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
H188 Subset A
23 Panels
72 Cracks
91.7% Detection
10 False Calls

Maximum Likelihood Analysis

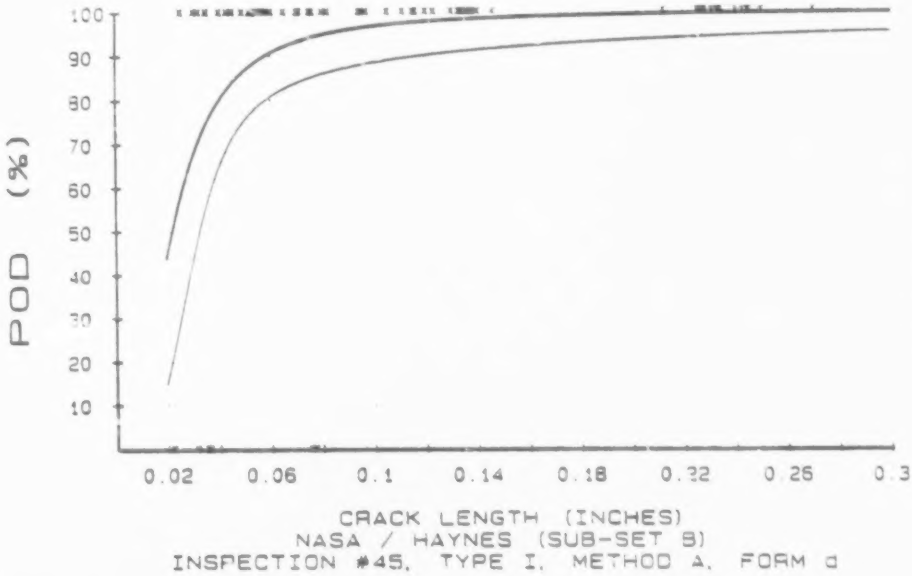
Figure B-43 Inspection #43 POD Curve



Inspection #44
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
H188 Subset B
21 Panels
68 Cracks
88.2% Detection
6 False Calls

Maximum Likelihood Analysis

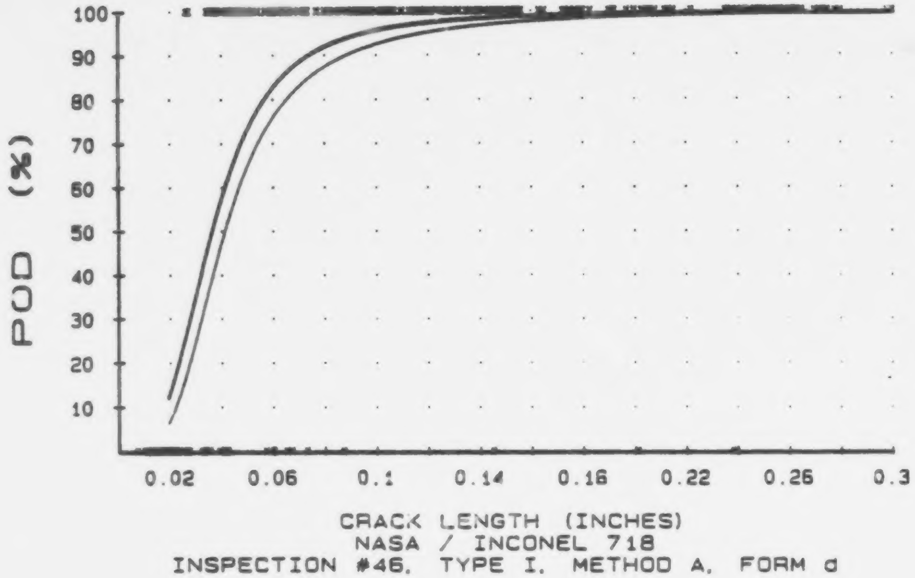
Figure B-44 Inspection #44 POD Curve



Inspection #45
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
H188 Subset B
21 Panels
68 Cracks
91.2% Detection
14 False Calls

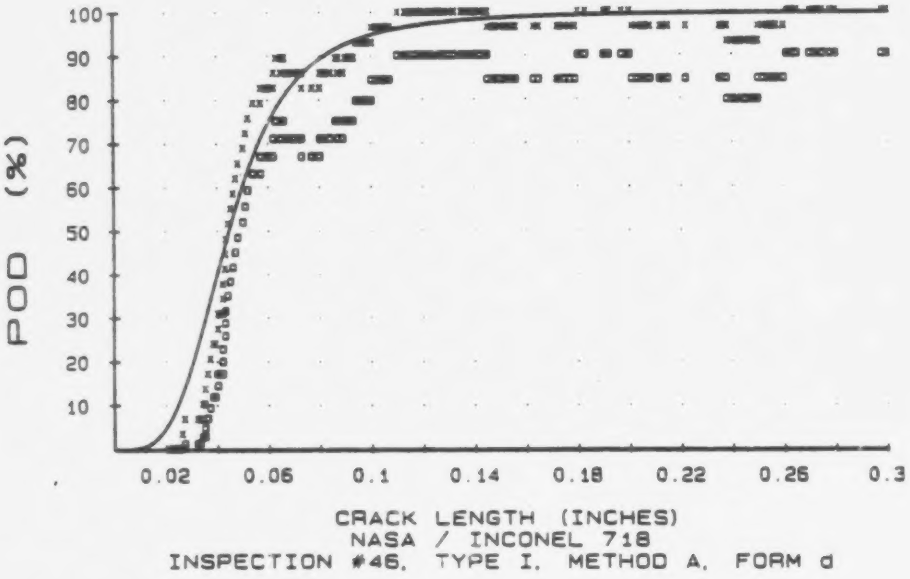
Maximum Likelihood Analysis

Figure B-45 Inspection #45 POD Curve



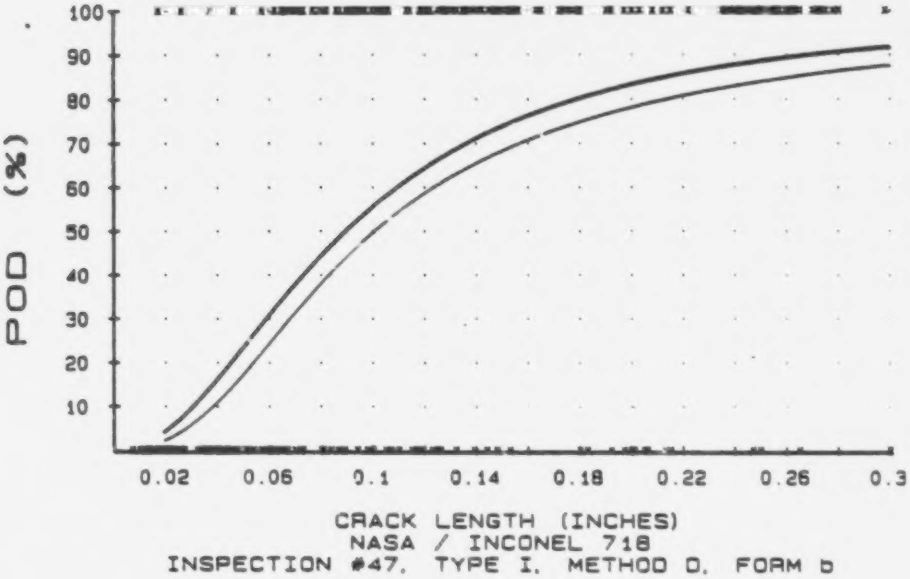
Inspection #46
Type I Penetrant
Sensitivity 3
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
81.5% Detection
1 False Calls

Maximum Likelihood Analysis



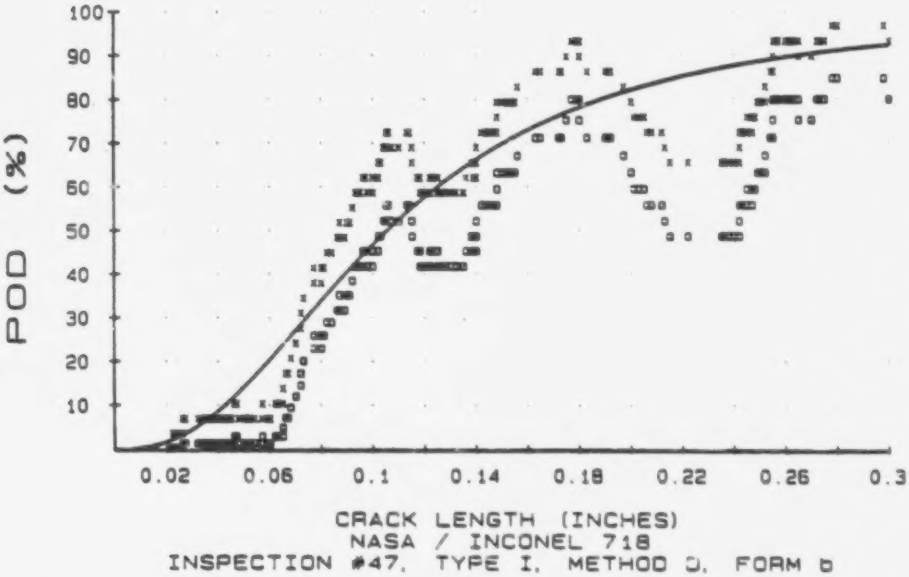
Moving Average Analysis

Figure B-46 Inspection #46 POD Curves



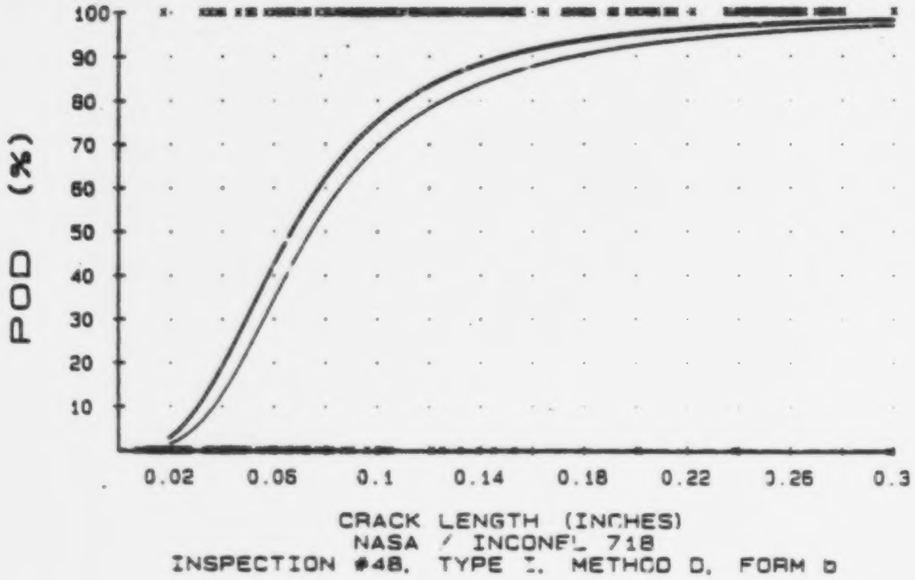
Inspection #47
Type I Penetrant
Sensitivity 3
Method D
Developer Form b
Inconel 718
110 Panels
281 Cracks
54.8% Detection
33 False Calls

Maximum Likelihood Analysis



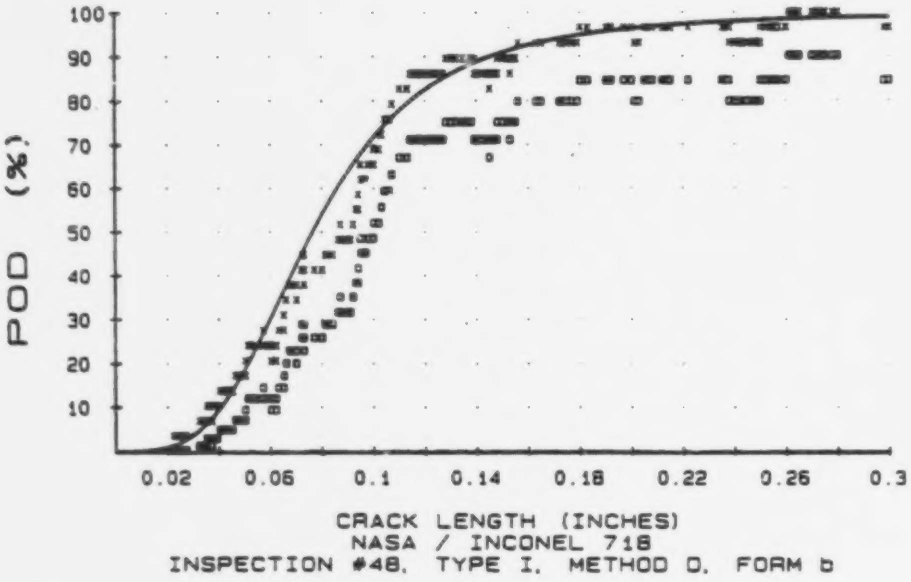
Moving Average Analysis

Figure B-47 Inspection #47 POD Curves



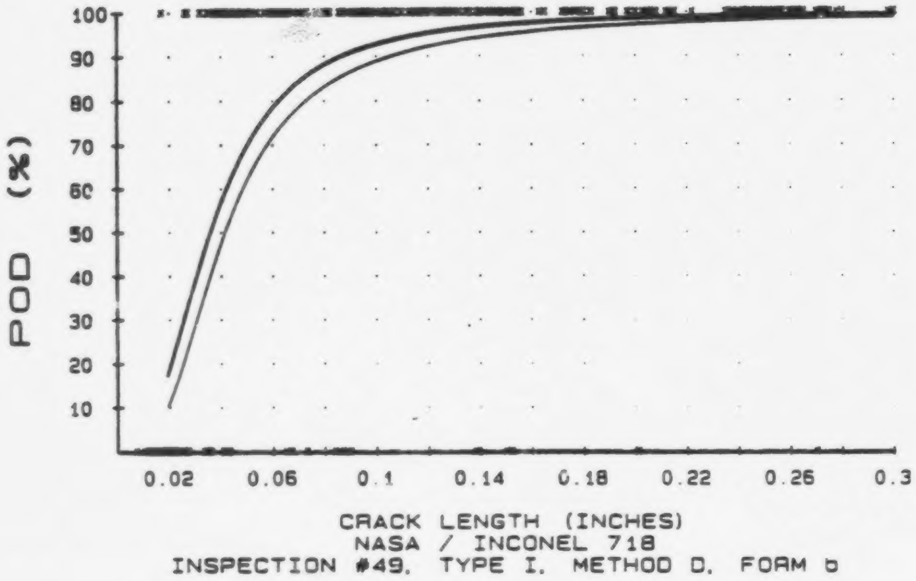
Inspection #48
Type I Penetrant
Sensitivity 3
Method D
Developer Form b
Inconel 718
110 Panels
281 Cracks
65.8% Detection
22 False Calls

Maximum Likelihood Analysis



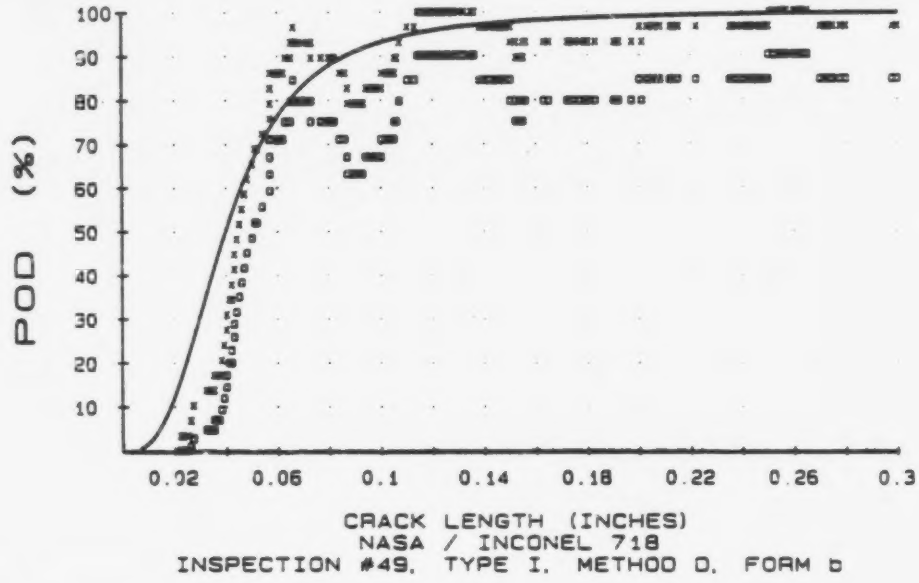
Moving Average Analysis

Figure B-48 Inspection #48 POD Curves



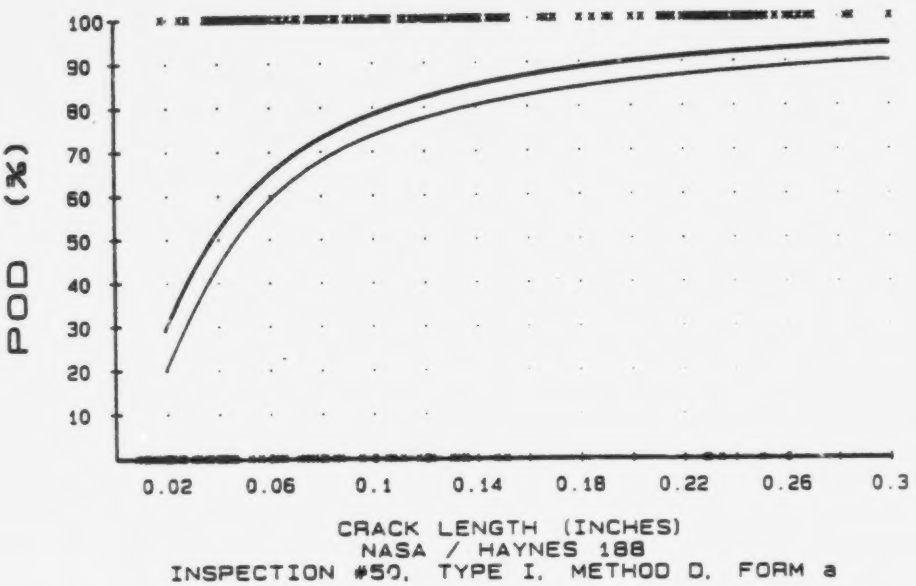
Inspection #49
Type I Penetrant
Sensitivity 3
Method D
Developer Form b
Inconel 718
110 Panels
281 Cracks
80.4% Detection
28 False Calls

Maximum Likelihood Analysis



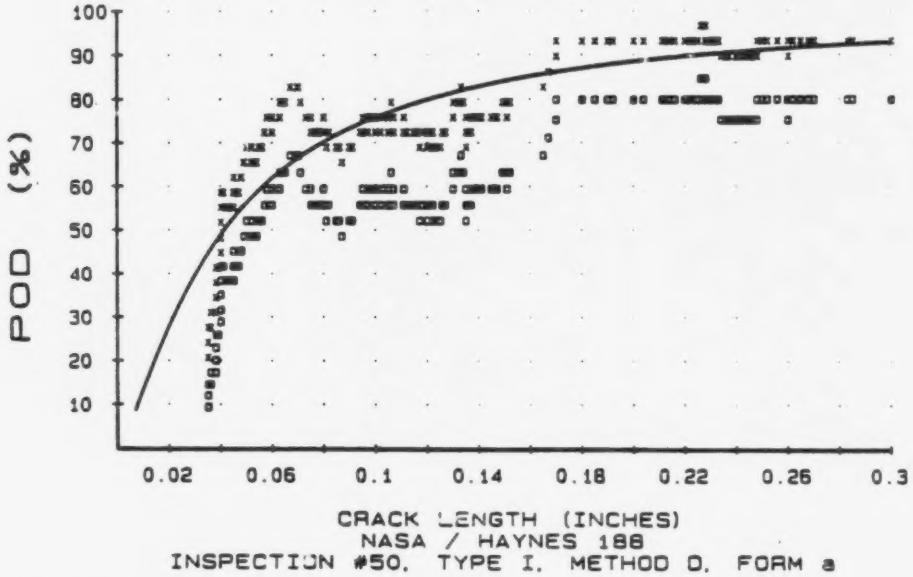
Moving Average Analysis

Figure B-49 Inspection #49 POD Curves



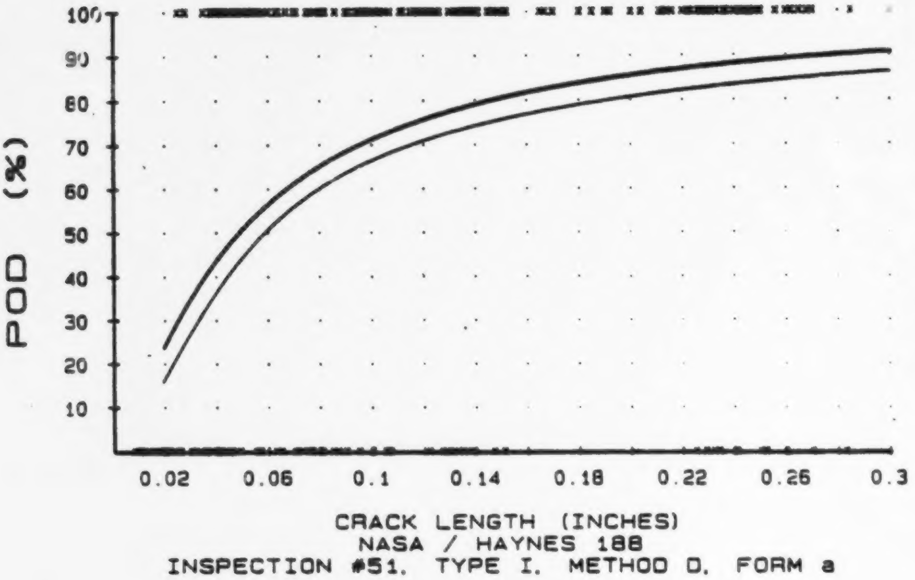
Inspection #50
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
Haynes 188
102 Panels
284 Cracks
73.6% Detection
12 False Calls

Maximum Likelihood Analysis



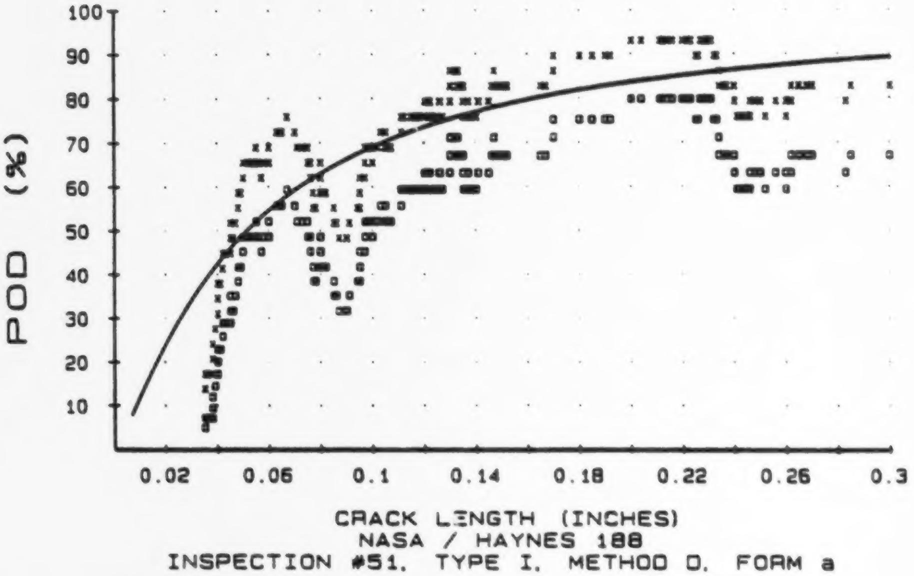
Moving Average Analysis

Figure B-50 Inspection #50 POD Curves



Inspection #51
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
Haynes 188
102 Panels
284 Cracks
67.6% Detection
8 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

Figure B-51 Inspection #51 POD Curves

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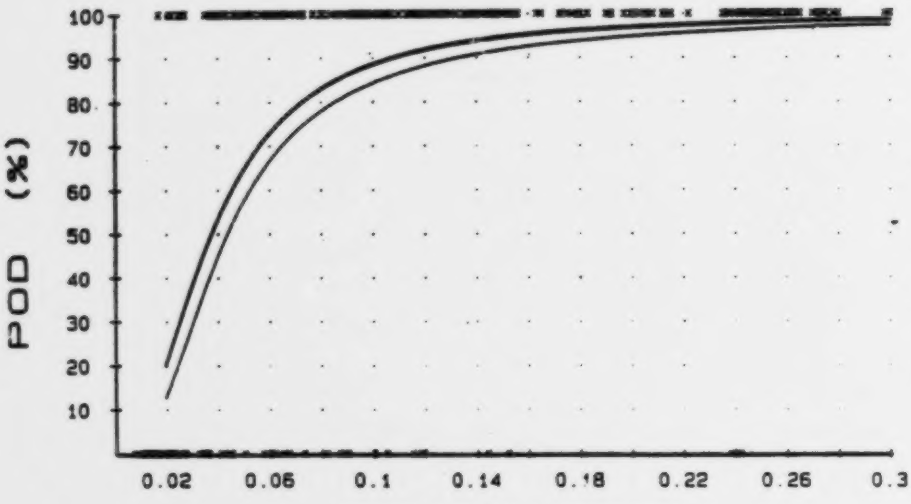
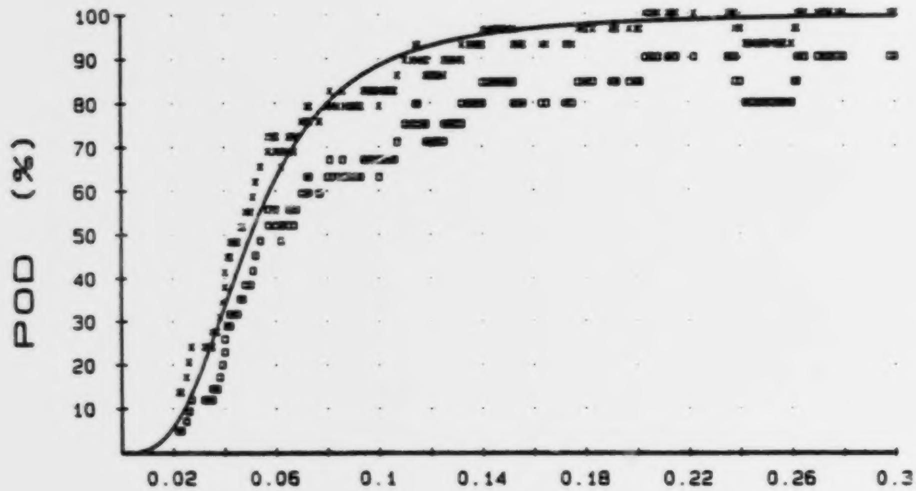


Inspection #52
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
Inconel 718
110 Panels
281 Cracks
78.3% Detection
9 False Calls

CRACK LENGTH (INCHES)
NASA / INCONEL 718
INSPECTION #52, TYPE I, METHOD D, FORM a

Maximum Likelihood Analysis



CRACK LENGTH (INCHES)
NASA / INCONEL 718
INSPECTION #52, TYPE I, METHOD D, FORM a

Moving Average Analysis

Figure B-52 Inspection #52 POD Curves

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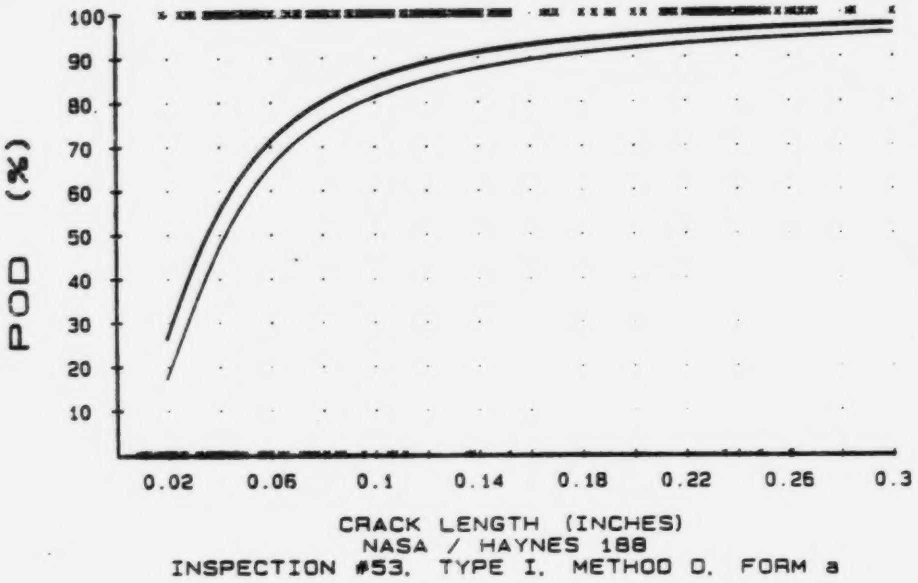
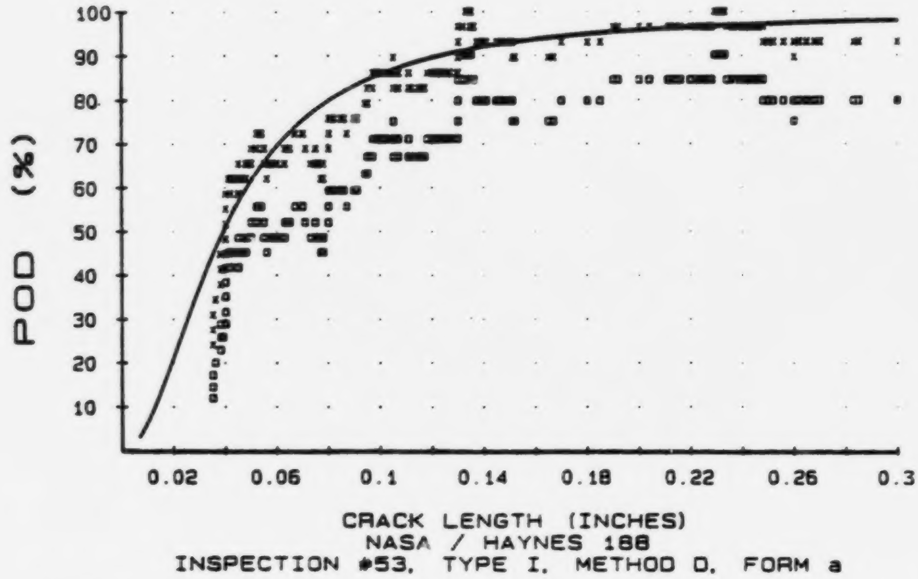


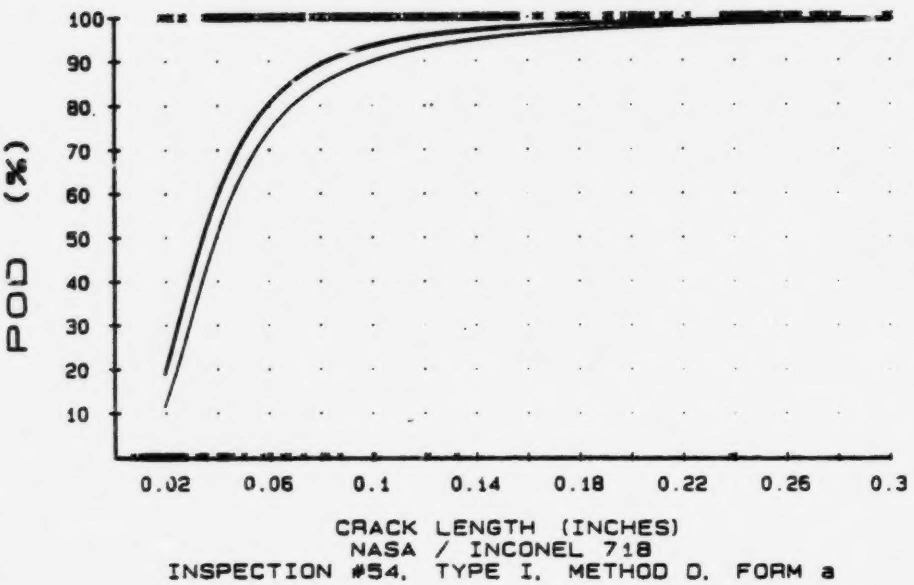
Inspection #53
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
Haynes 188
102 Panels
284 Cracks
78.5% Detection
3 False Calls

Maximum Likelihood Analysis



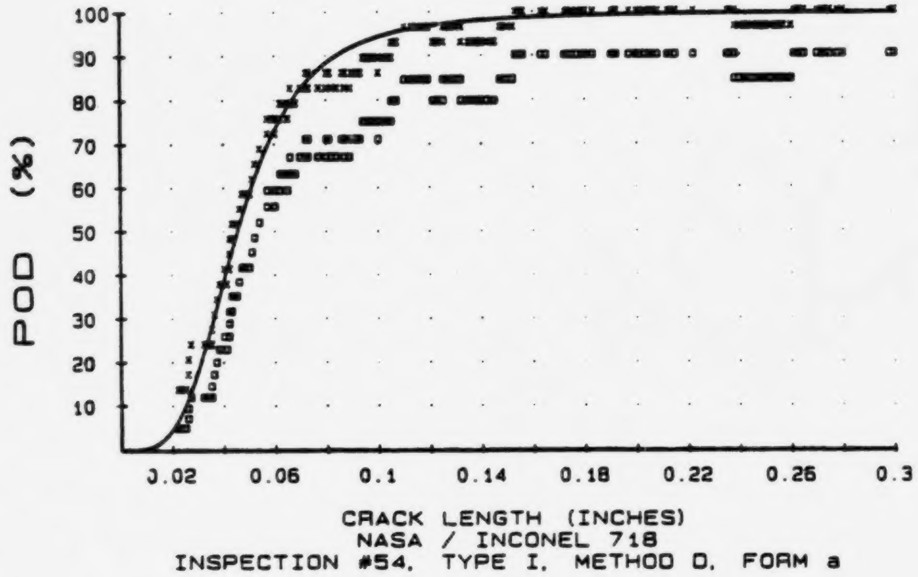
Moving Average Analysis

Figure B-53 Inspection #53 POD Curves



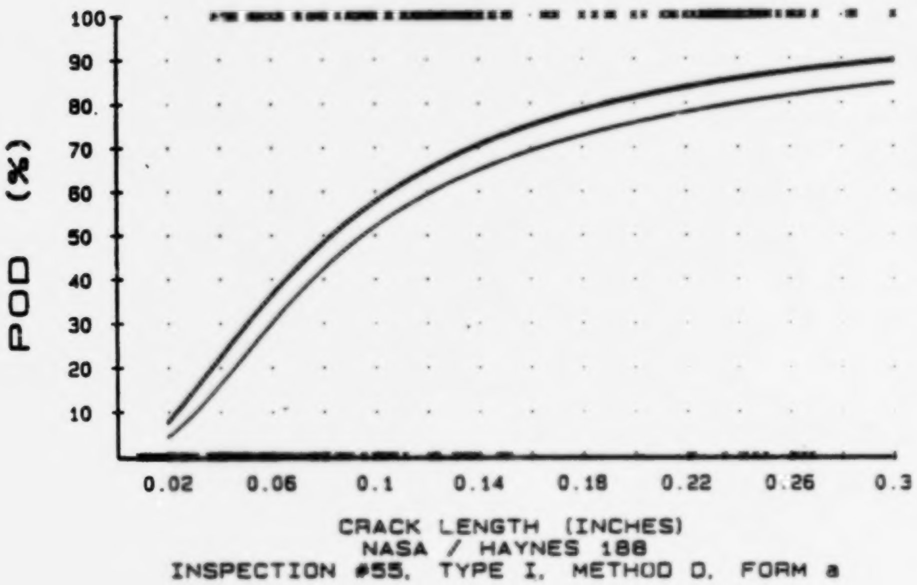
Inspection #54
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
Inconel 718
110 Panels
281 Cracks
81.5% Detection
8 False Calls

Maximum Likelihood Analysis



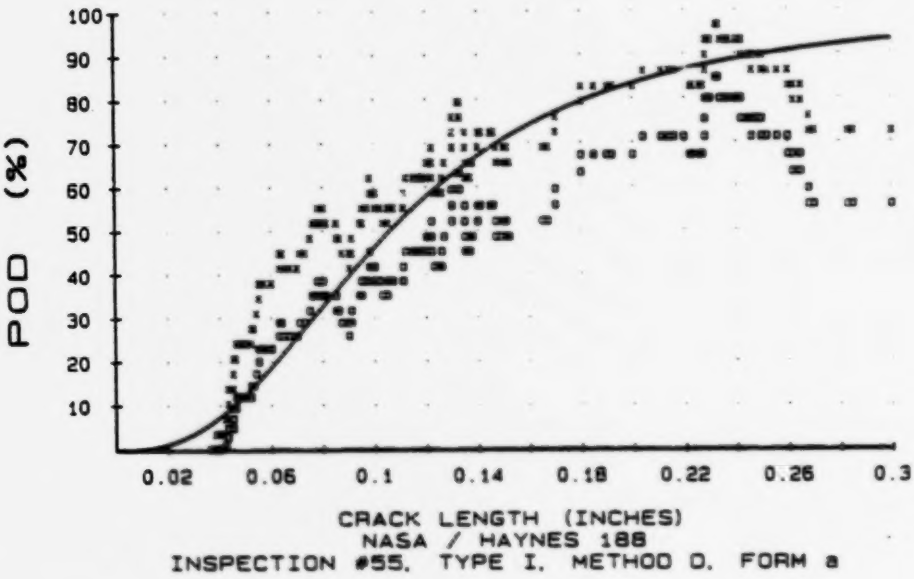
Moving Average Analysis

Figure B-54 Inspection #54 POD Curves



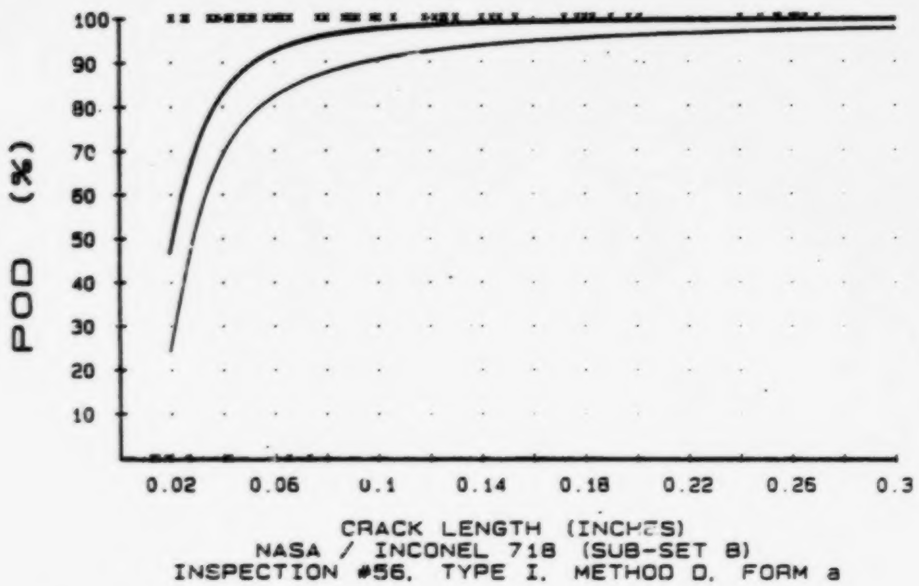
Inspection #55
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
Haynes 188
102 Panels
284 Cracks
56.0% Detection
17 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

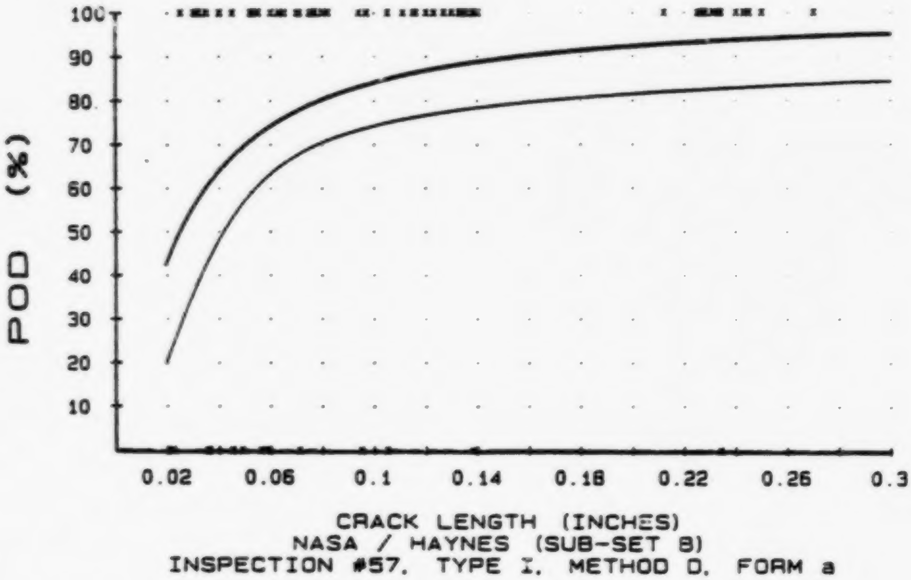
Figure B-55 Inspection #55 POD Curves



Inspection #56
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
I718 Subset B
23 Panels
70 Cracks
88.6% Detection
2 False Calls

Maximum Likelihood Analysis

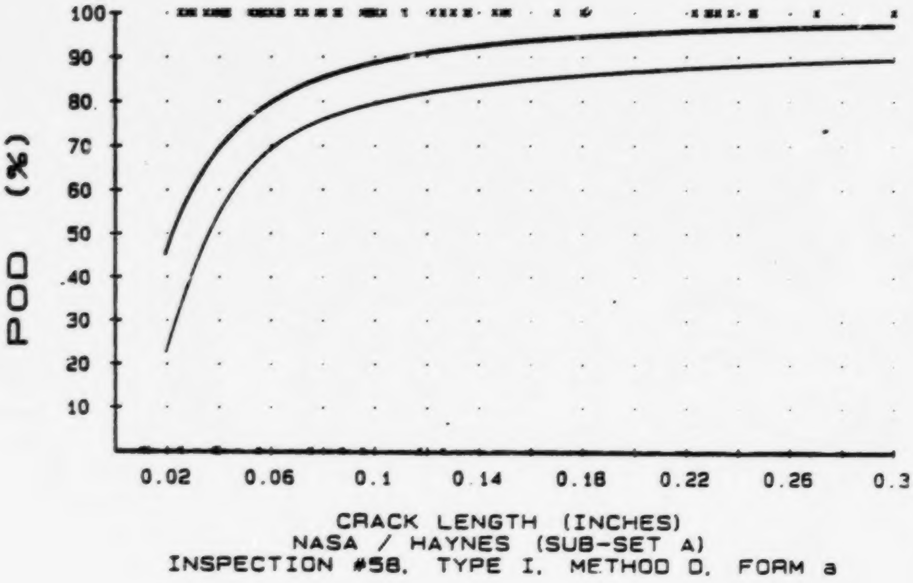
Figure B-56 Inspection #56 POD Curve



Inspection #57
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
H188 Subset B
19 Panels
68 Cracks
79.4% Detection
1 False Calls

Maximum Likelihood Analysis

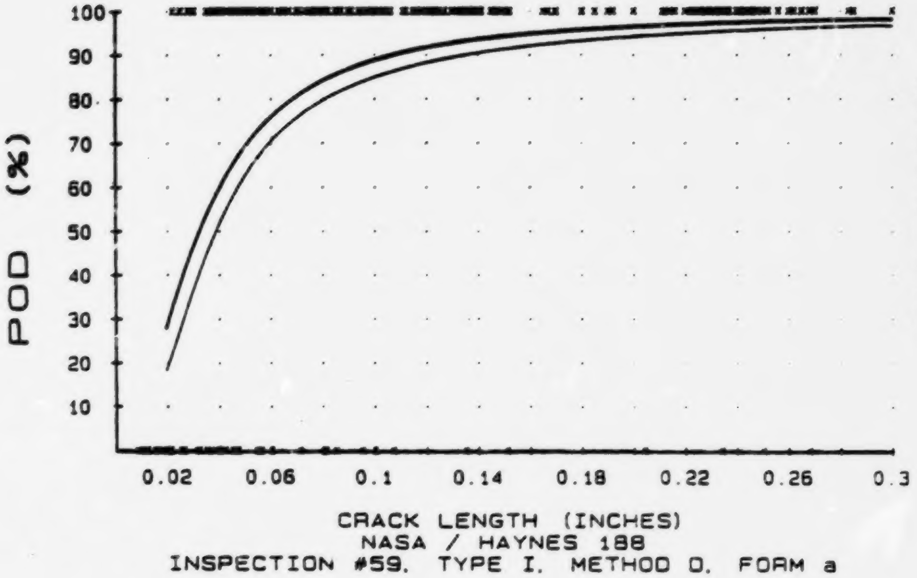
Figure B-57 Inspection #57 POD Curve



Inspection #58
Type I Penetrant
Sensitivity 4
Method D
Developer Form a
H188 Subset A
20 Panels
68 Cracks
82.4% Detection
2 False Calls

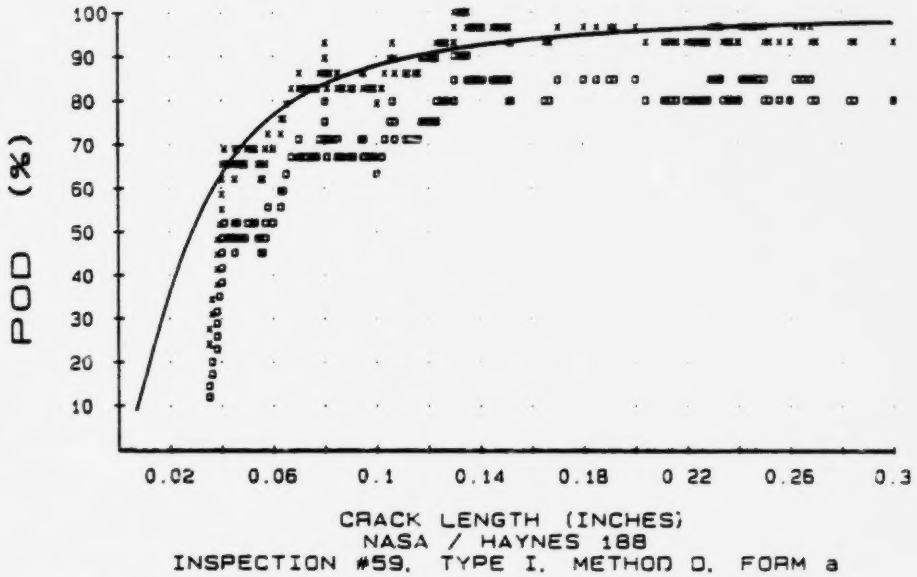
Maximum Likelihood Analysis

Figure B-58 Inspection #58 POD Curve



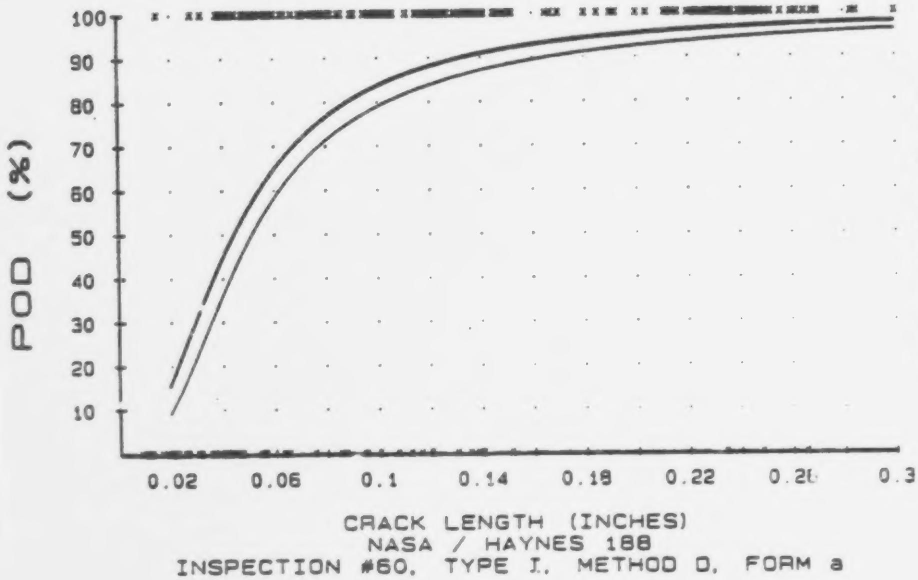
Inspection #59
Type I Penetrant
Sensitivity 4
Method D
Developer Form b
Haynes 188
102 Panels
284 Cracks
81.3% Detection
10 False Calls

Maximum Likelihood Analysis



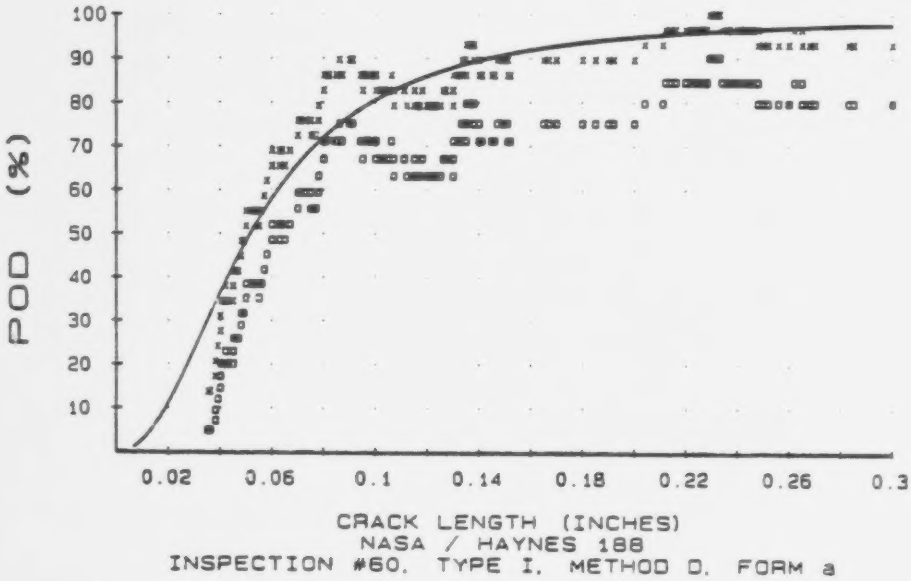
Moving Average Analysis

Figure B-59 Inspection #59 POD Curves



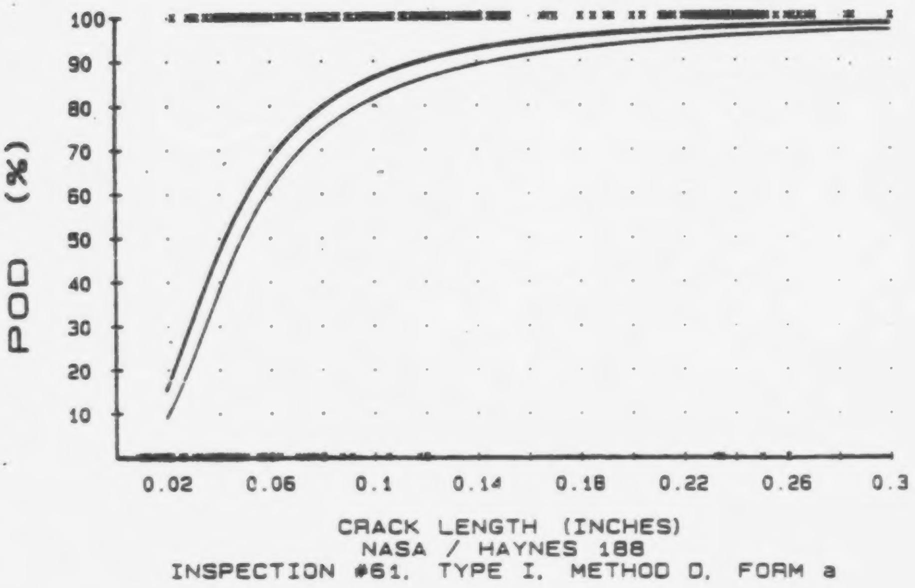
Inspection #60
Type I Penetrant
Sensitivity 4
Method D
Developer Form b
Haynes 188
102 Panels
284 Cracks
75.0% Detection
204 False Calls

Maximum Likelihood Analysis



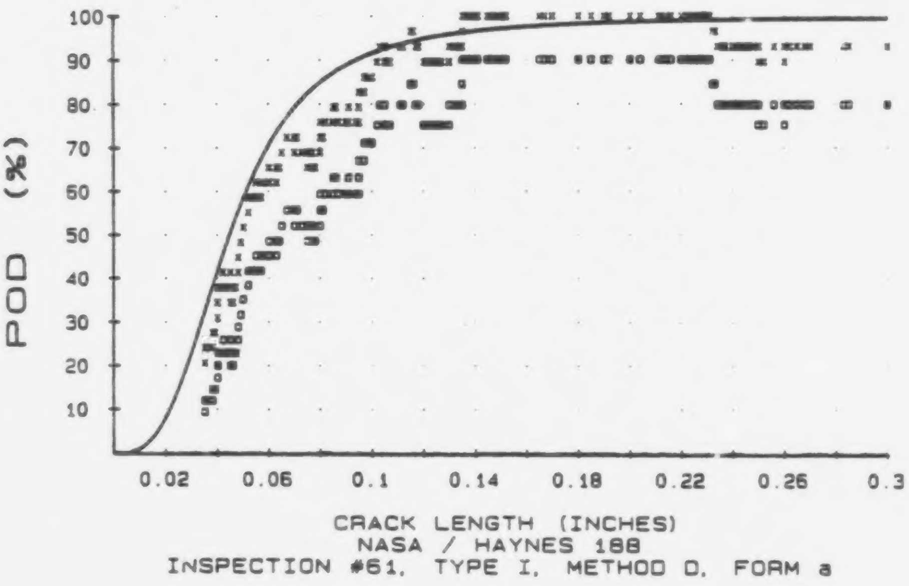
Moving Average Analysis

Figure B-60 Inspection #60 POD Curves



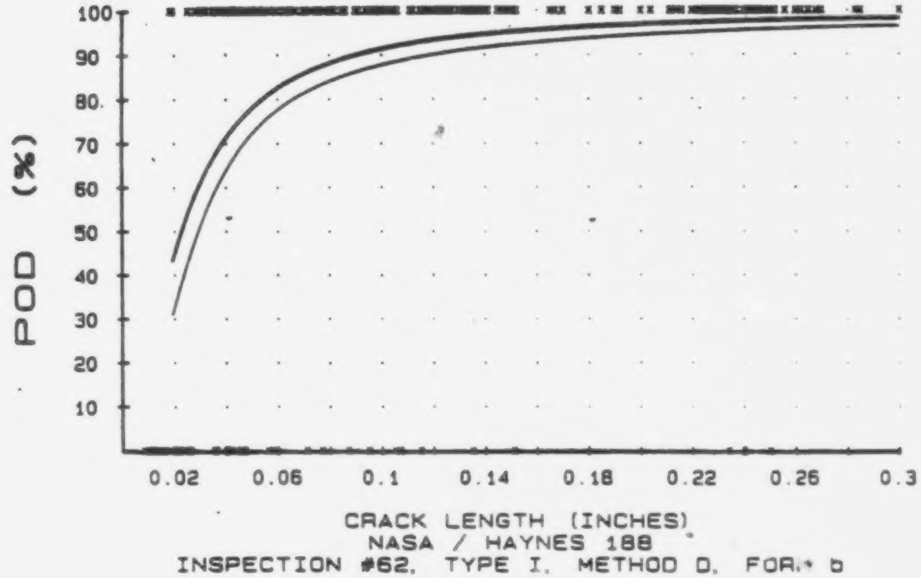
Inspection #61
Type I Penetrant
Sensitivity 4
Method D
Developer Form b
Haynes 188
102 Panels
284 Cracks
76.8% Detection
204 False Calls

Maximum Likelihood Analysis



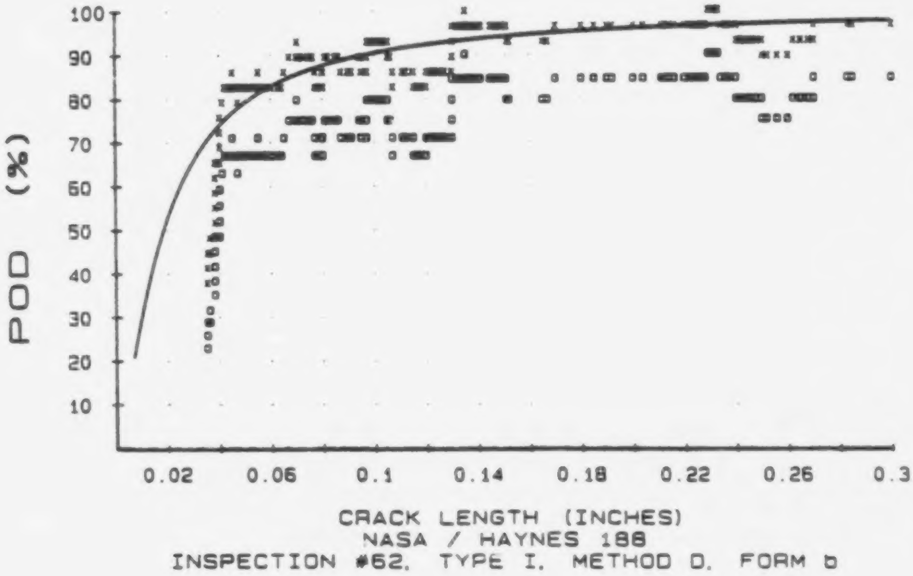
Moving Average Analysis

Figure B-61 Inspection #61 POD Curves



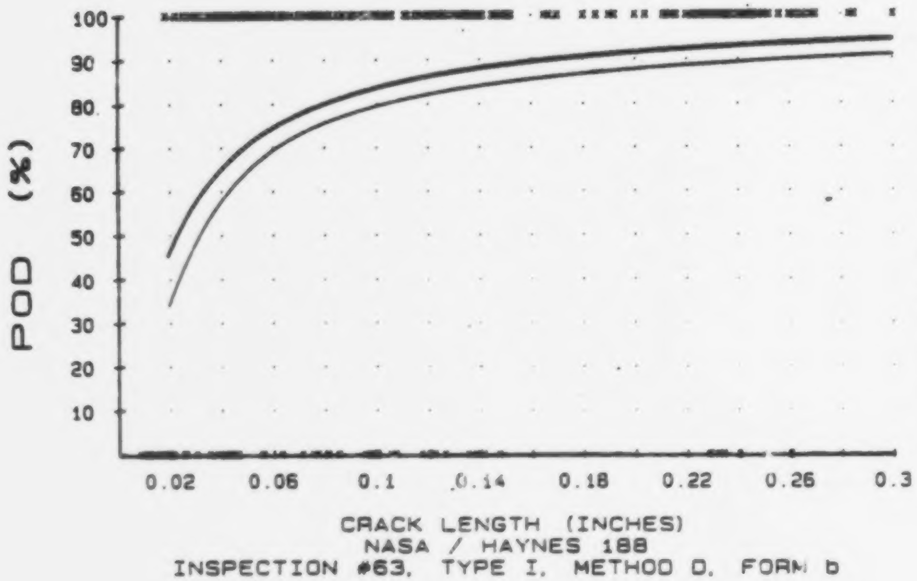
Inspection #62
Type I Penetrant
Sensitivity 4
Method D
Developer Form b
Haynes 188
102 Panels
284 Cracks
85.6% Detection
6 False Calls

Maximum Likelihood Analysis



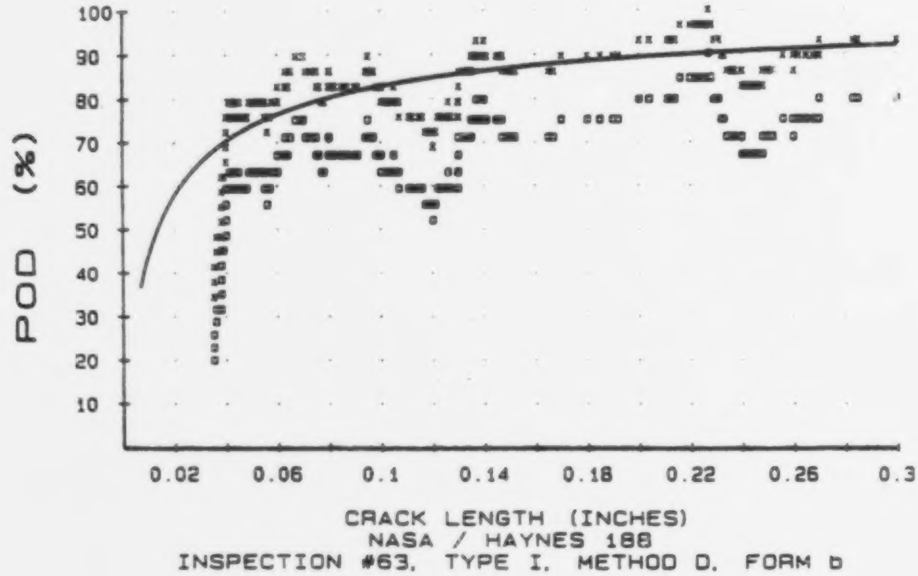
Moving Average Analysis

Figure B-62 Inspection #62 POD Curves



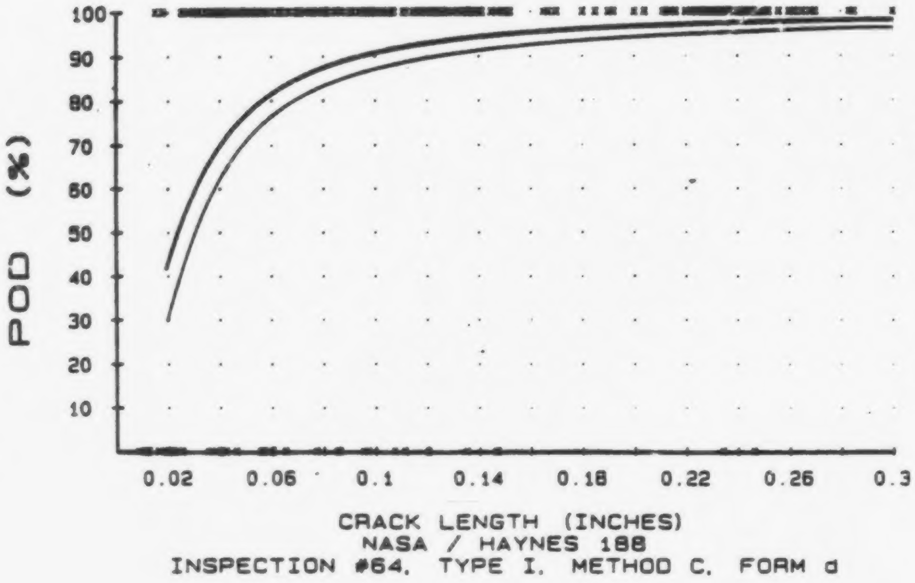
Inspection #63
Type I Penetrant
Sensitivity 4
Method D
Developer Form b
Haynes 188
102 Panels
284 Cracks
79.9% Detection
60 False Calls

Maximum Likelihood Analysis



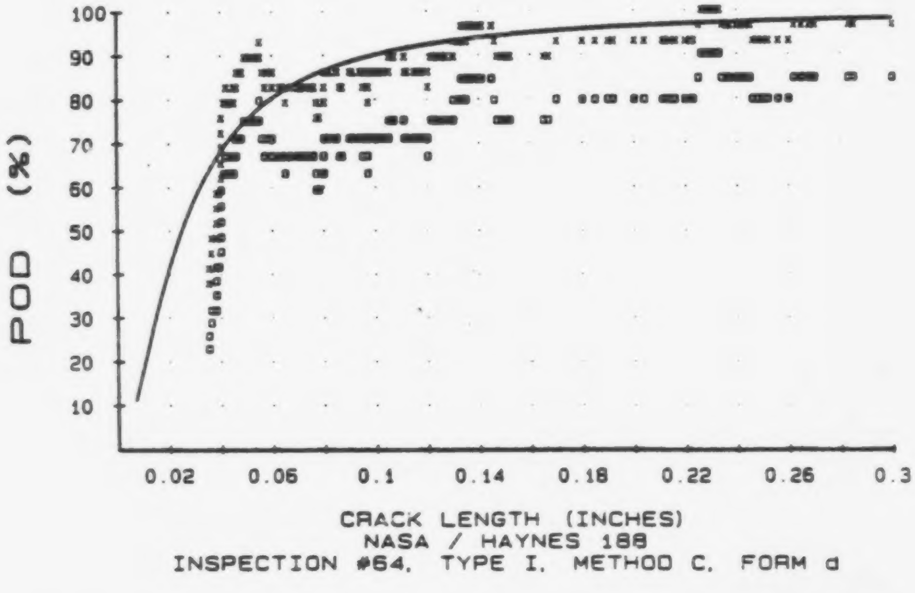
Moving Average Analysis

Figure B-63 Inspection #63 POD Curves



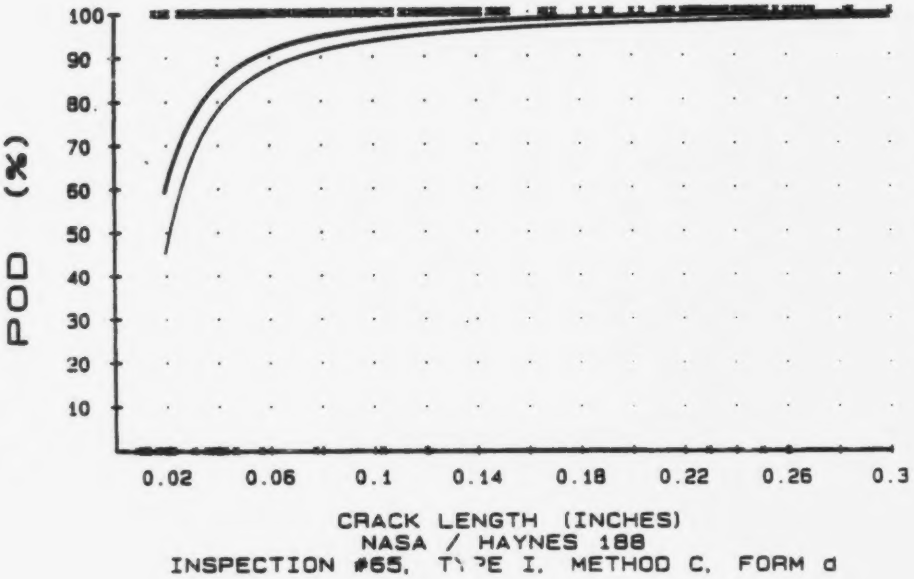
Inspection #64
Type I Penetrant
Sensitivity 3
Method C
Developer Form d
Haynes 188
102 Panels
284 Cracks
84.9% Detection
34 False Calls

Maximum Likelihood Analysis



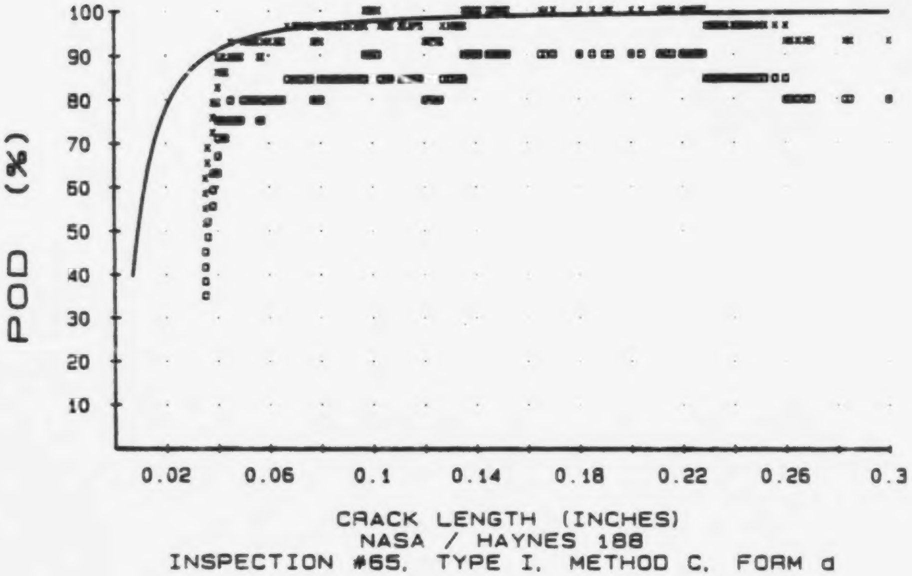
Moving Average Analysis

Figure B-64 Inspection #64 POD Curves



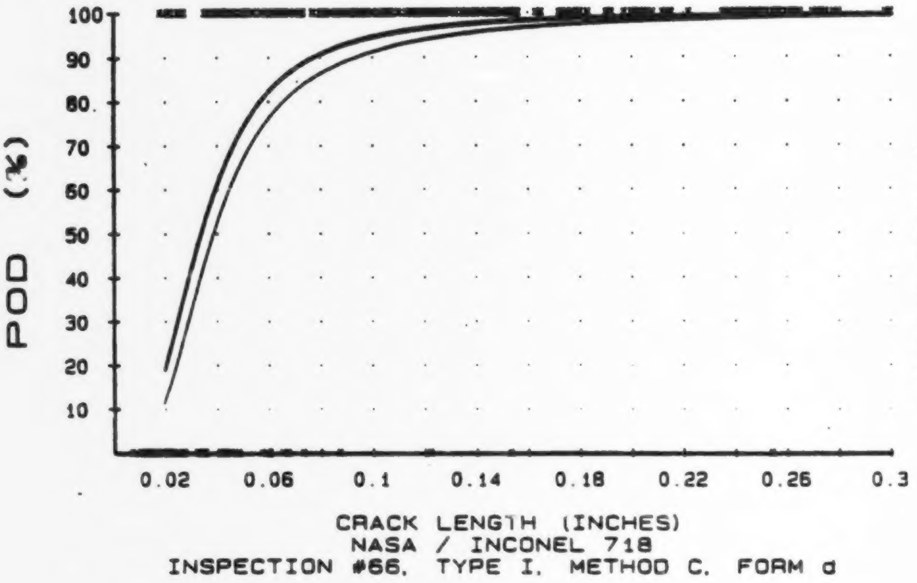
Inspection #65
Type I Penetrant
Sensitivity 3
Method C
Developer Form d
Haynes 188
102 Panels
284 Cracks
91.5% Detection
37 False Calls

Maximum Likelihood Analysis



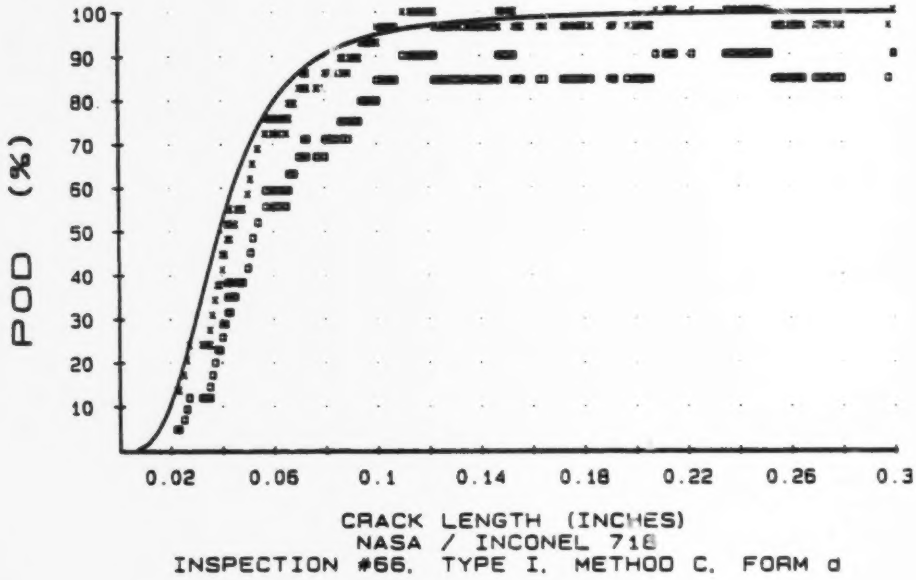
Moving Average Analysis

Figure B-65 Inspection #65 POD Curves



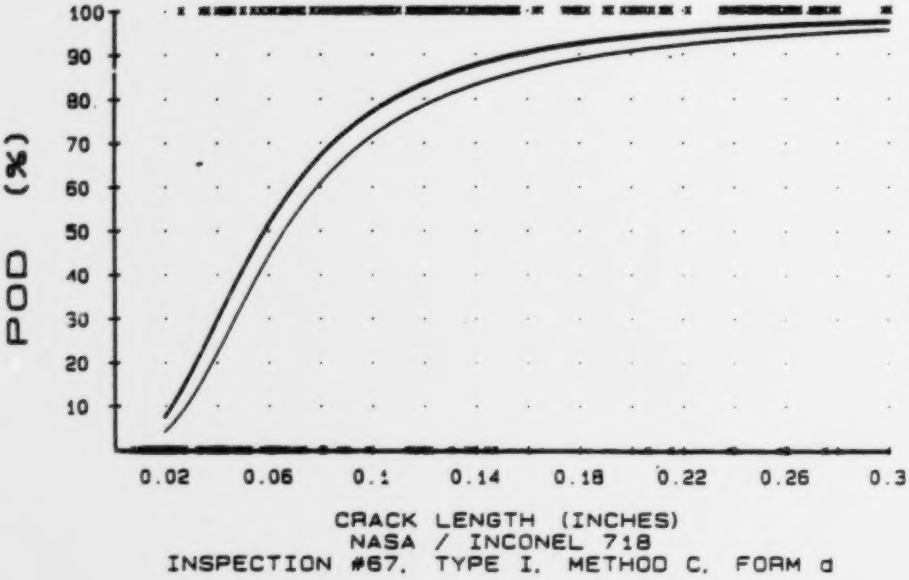
Inspection #66
Type I Penetrant
Sensitivity 3
Method C
Developer Form d
Inconel 718
110 Panels
281 Cracks
82.2% Detection
12 False Calls

Maximum Likelihood Analysis



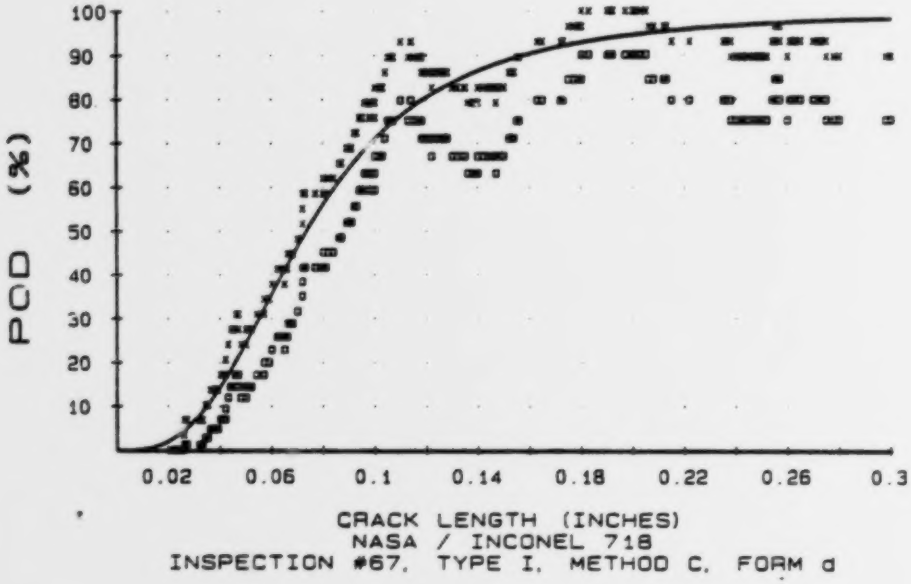
Moving Average Analysis

Figure B-66 Inspection #66 POD Curves



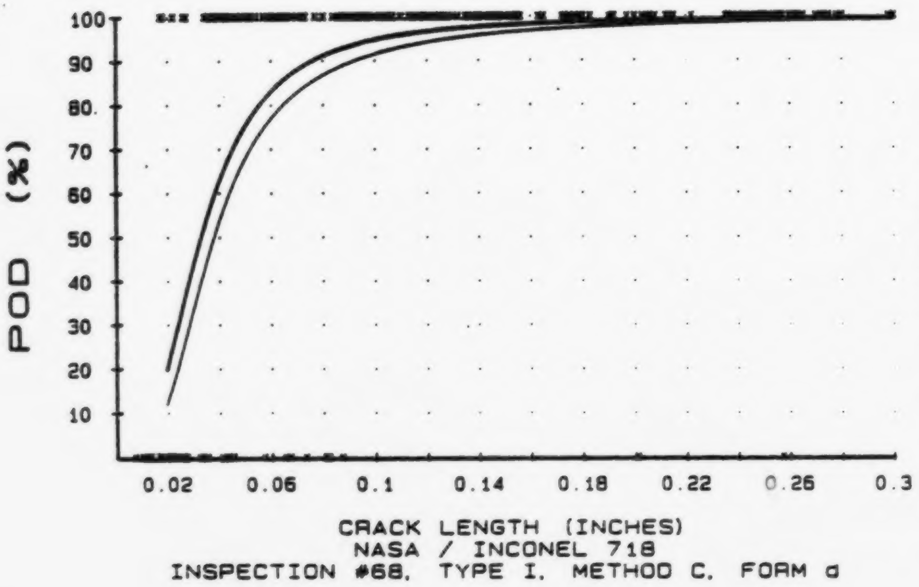
Inspection #67
Type I Penetrant
Sensitivity 3
Method C
Developer Form d
Inconel 718
110 Panels
281 Cracks
68.3% Detection
3 False Calls

Maximum Likelihood Analysis



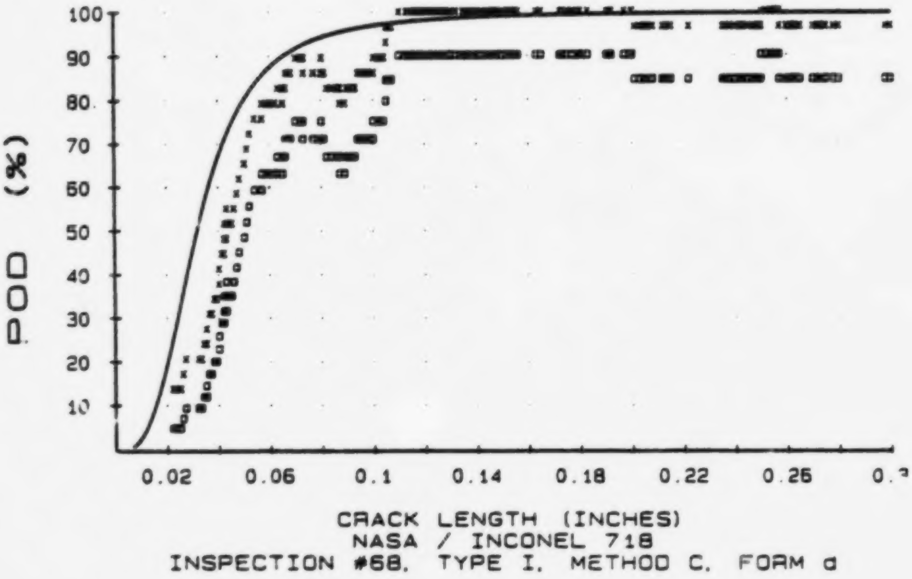
Moving Average Analysis

Figure B-67 Inspection #67 POD Curves



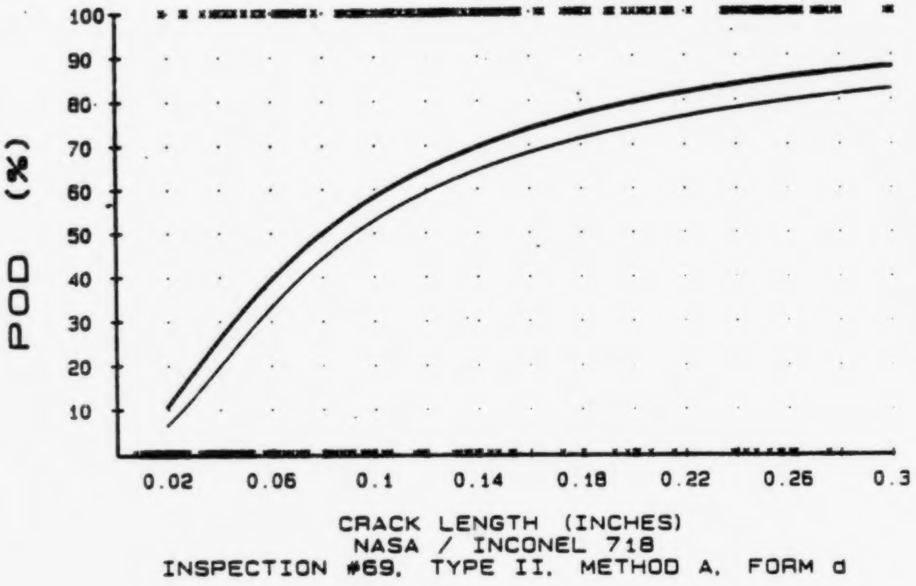
Inspection #68
Type I Penetrant
Sensitivity 3
Method C
Developer Form d
Inconel 718
110 Panels
281 Cracks
82.5% Detection
5 False Calls

Maximum Likelihood Analysis



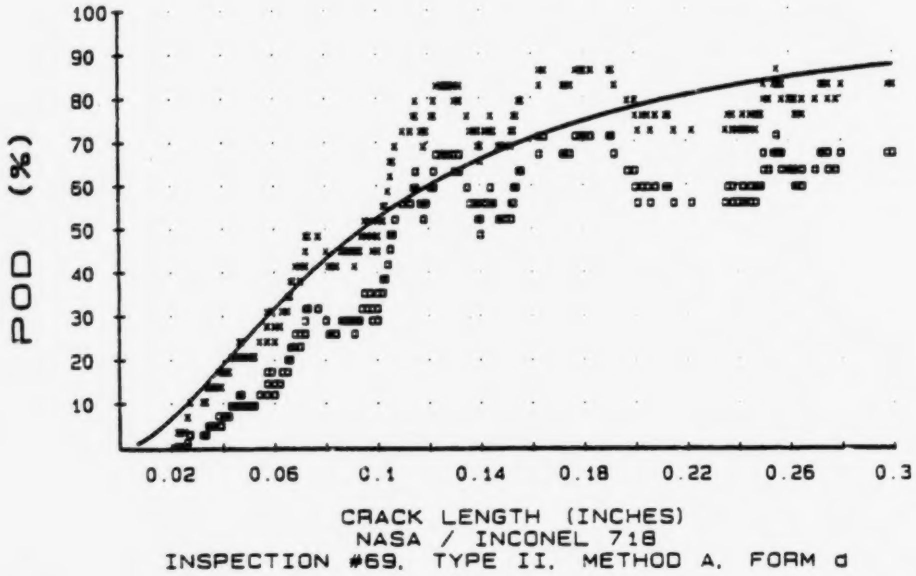
Moving Average Analysis

Figure B-68 Inspection #68 POD Curves



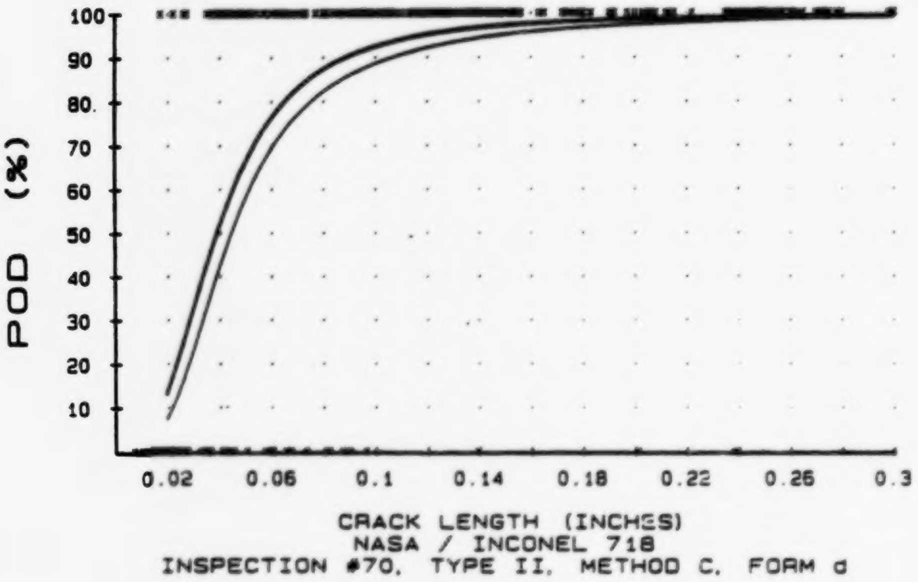
Inspection #69
Type II
Method A
Developer Form d
Inconel 718
110 Panels
281 Cracks
56.6% Detection
0 False Calls

Maximum Likelihood Analysis



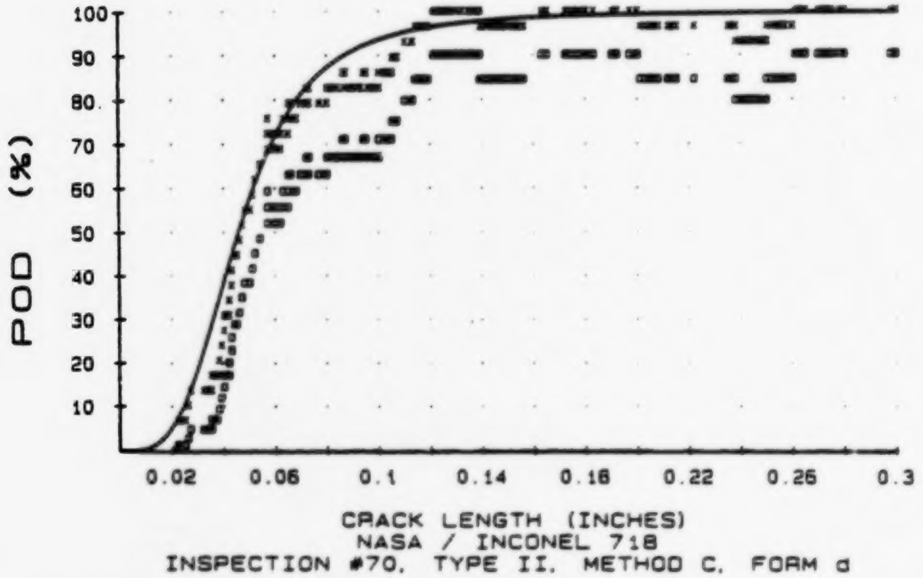
Moving Average Analysis

Figure B-69 Inspection #69 POD Curves



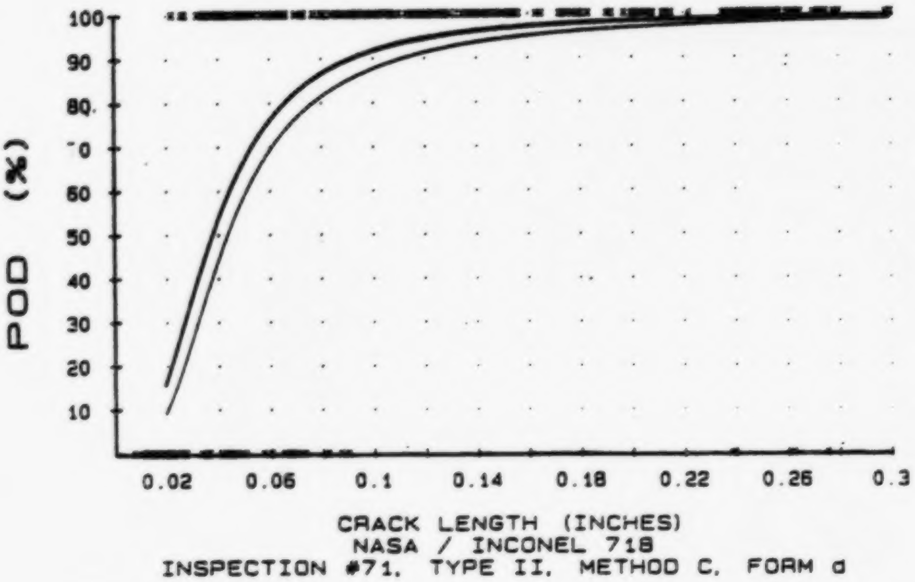
Inspection #70
Type II
Method C
Developer Form d
Inconel 718
110 Panels
281 Cracks
79.4% Detection
0 False Calls

Maximum Likelihood Analysis



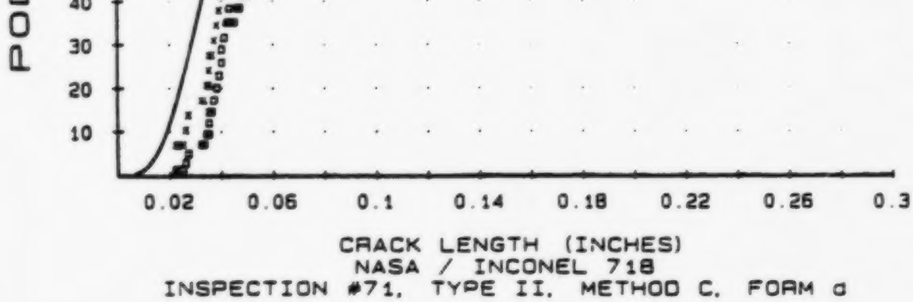
Moving Average Analysis

Figure B-70 Inspection #70 POD Curves



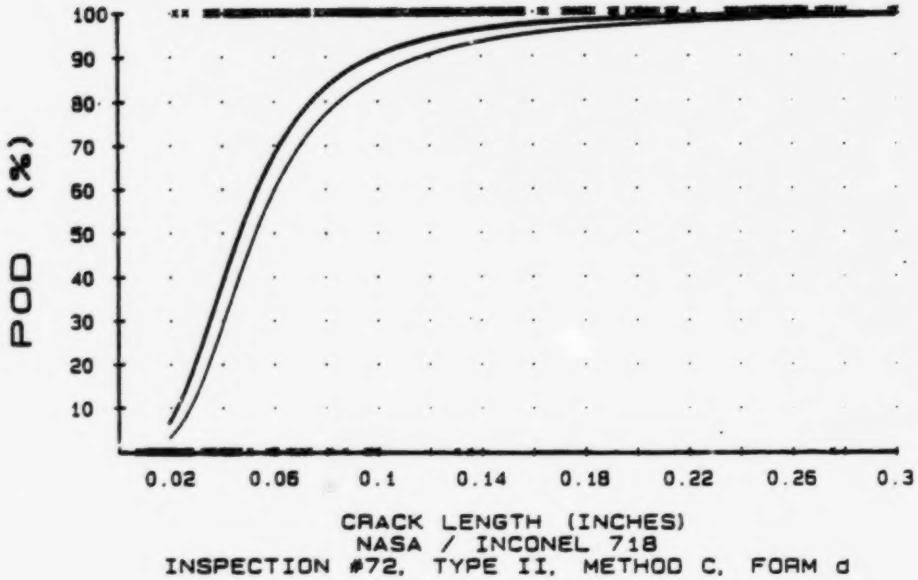
Inspection #71
Type II
Method C
Developer Form d
Inconel 718
110 Panels
281 Cracks
79.4% Detection
1 False Calls

Maximum Likelihood Analysis



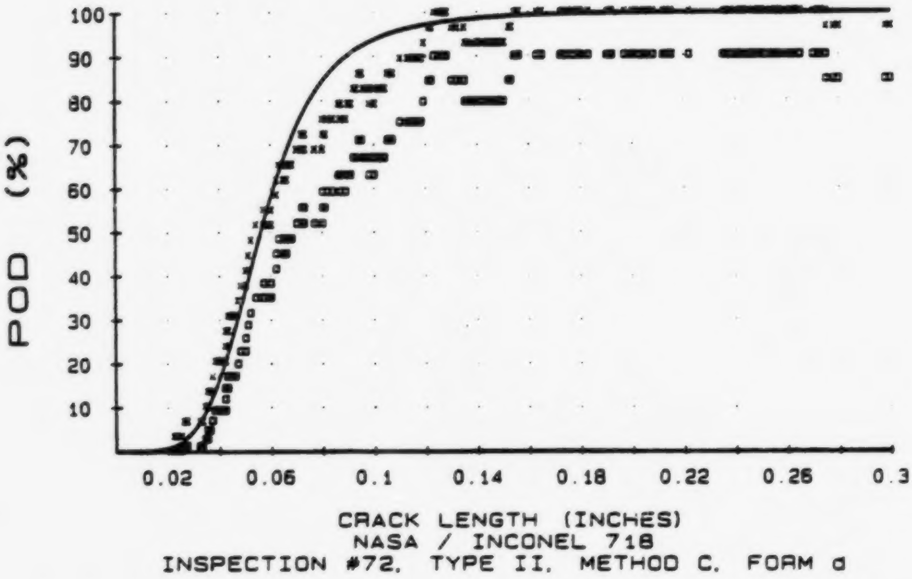
Moving Average Analysis

Figure B-71 Inspection #71 POD Curves



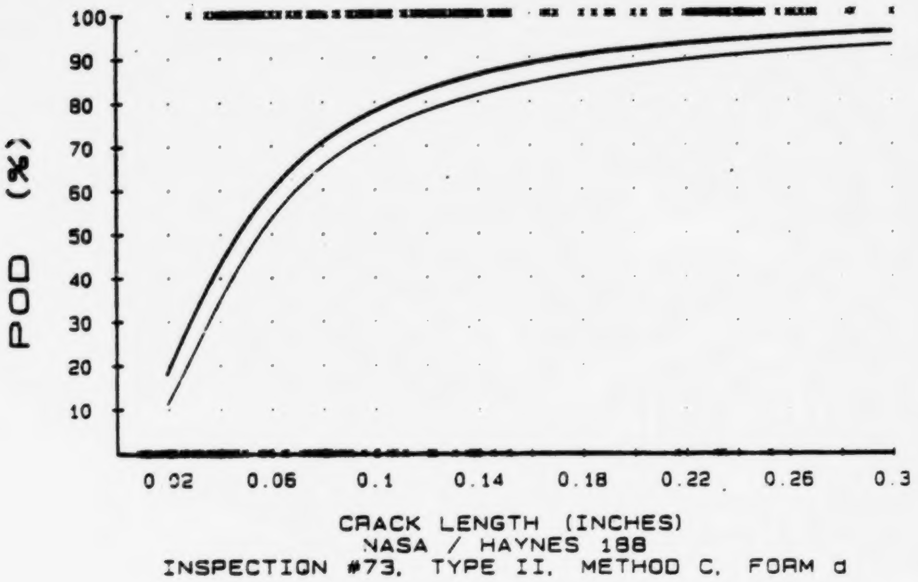
Inspection #72
Type II
Method C
Developer Form d
Inconel 718
110 Panels
281 Cracks
75.8% Detection
5 False Calls

Maximum Likelihood Analysis



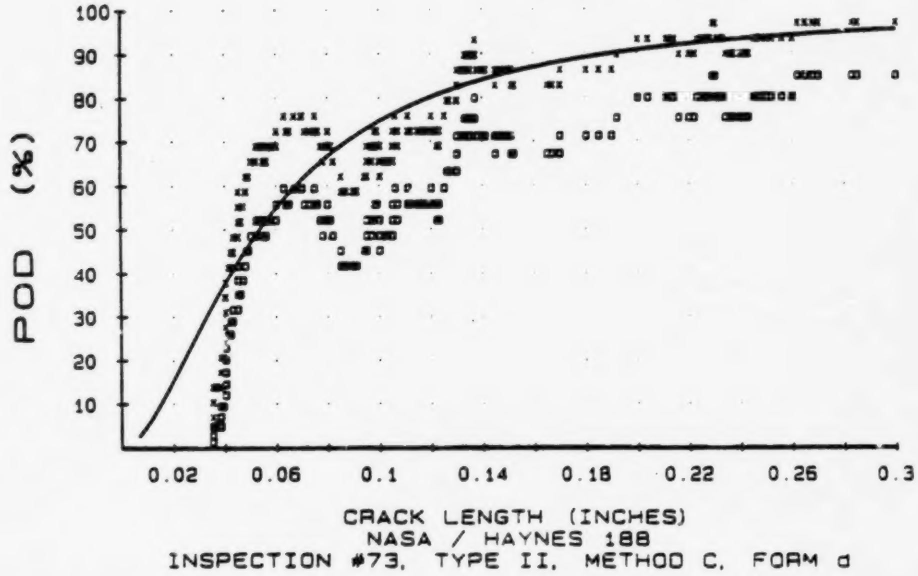
Moving Average Analysis

Figure B-72 Inspection #72 POD Curves



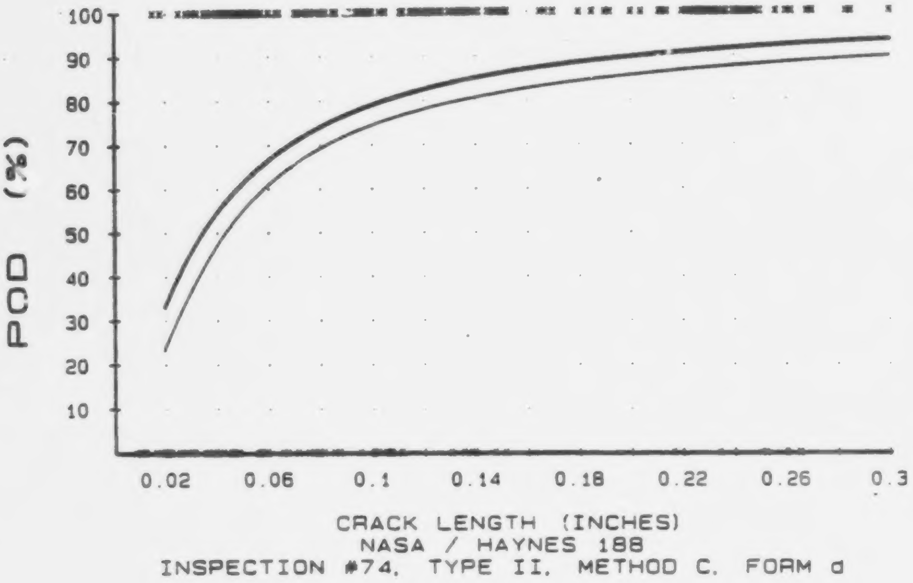
Inspection #73
Type II
Method C
Developer Form d
Haynes 188
102 Panels
284 Cracks
71.5% Detection
1 False Calls

Maximum Likelihood Analysis



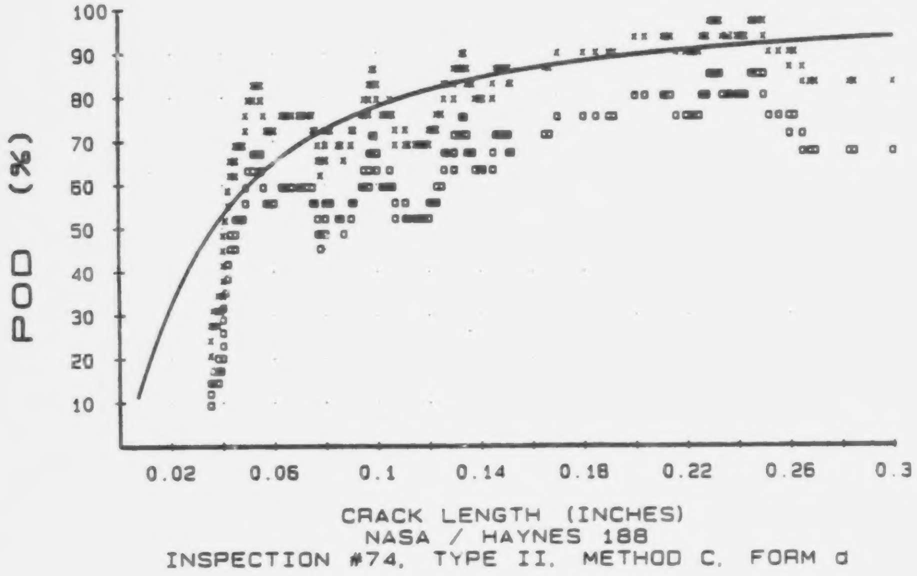
Moving Average Analysis

Figure B-73 Inspection #73 POD Curves



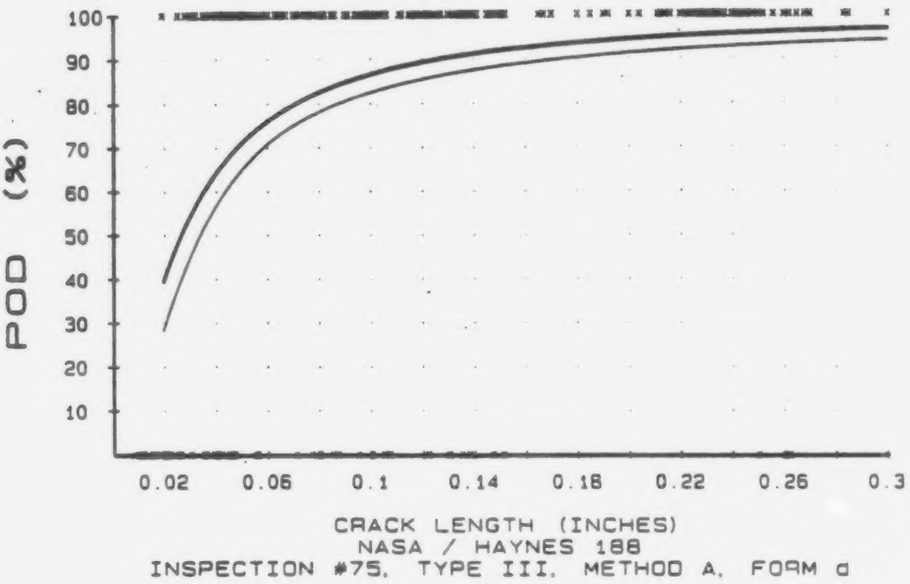
Inspection #74
Type II
Method C
Developer Form d
Haynes 188
102 Panels
284 Cracks
74.6% Detection
2 False Calls

Maximum Likelihood Analysis



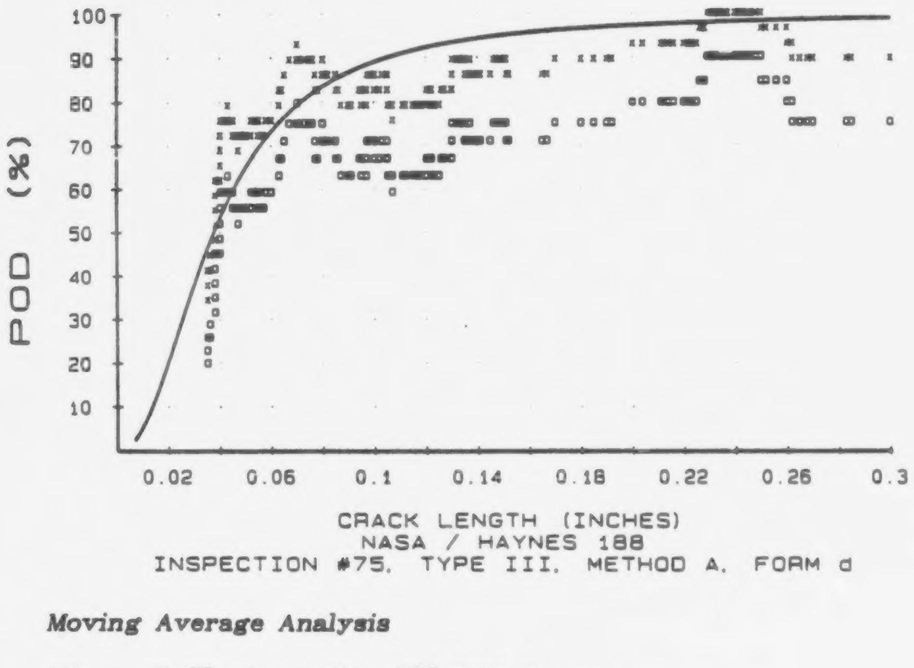
Moving Average Analysis

Figure B-74 Inspection #74 POD Curves



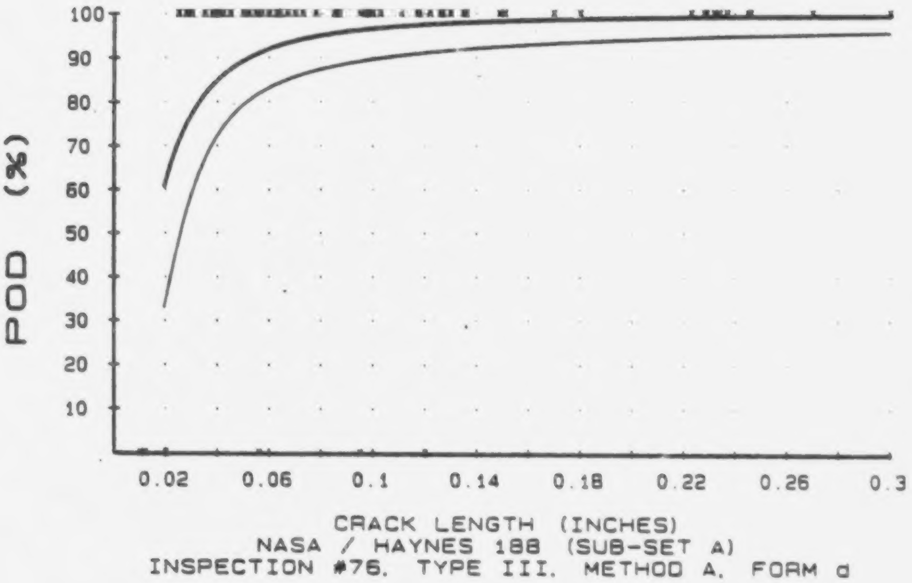
Inspection #75
Type III
Method A
Developer Rev. d
Haynes 188
102 Panels
284 Cracks
81.3% Detection
10 False Calls

Maximum Likelihood Analysis



Moving Average Analysis

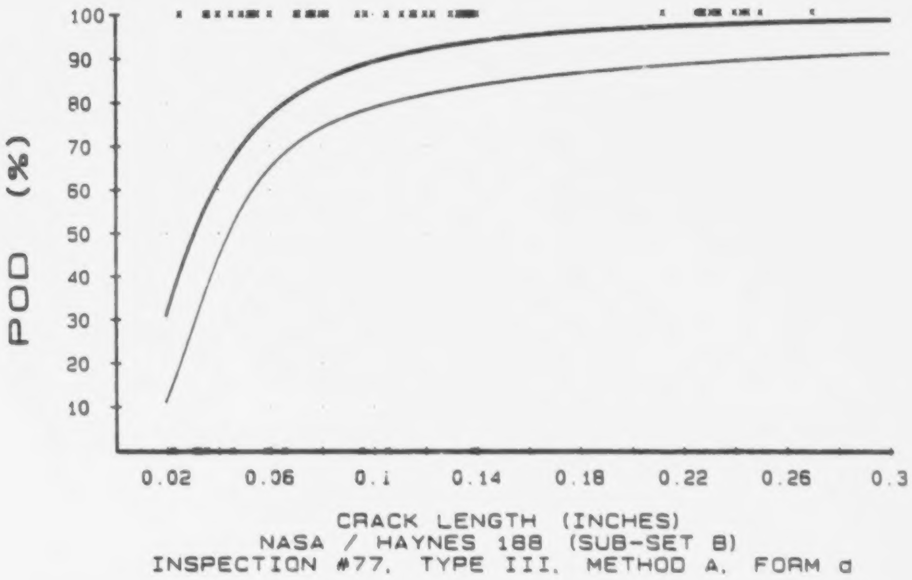
Figure B-75 Inspection #75 POD Curves



Inspection #76
Type III
Method A
Developer Rev. d
H188 Subset A
20 Panels
72 Cracks
91.7% Detection
1 False Calls

Maximum Likelihood Analysis

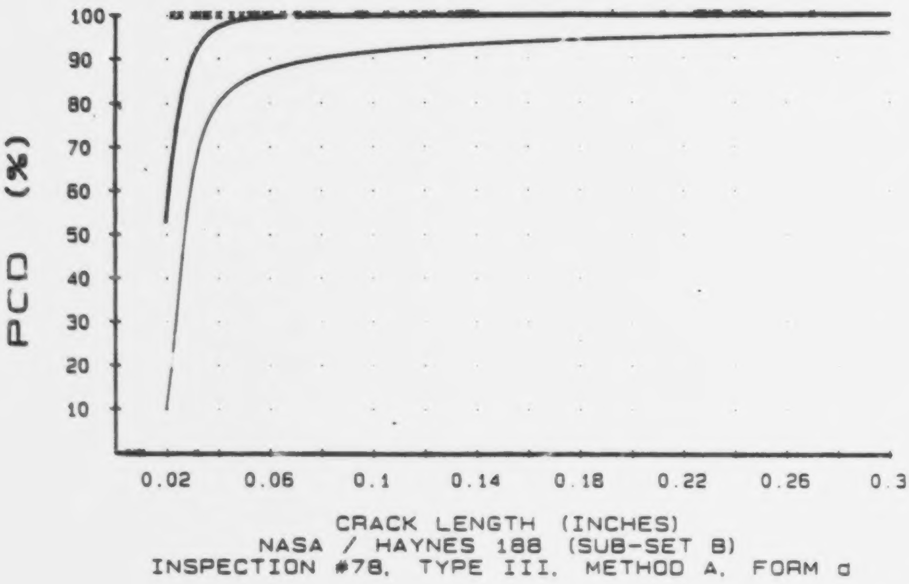
Figure B-76 Inspection #76 POD Curve



Inspection #77
Type III
Method A
Developer Rev. d
H188 Subset B
16 Panels
62 Cracks
82.3% Detection
2 False Calls

Maximum Likelihood Analysis

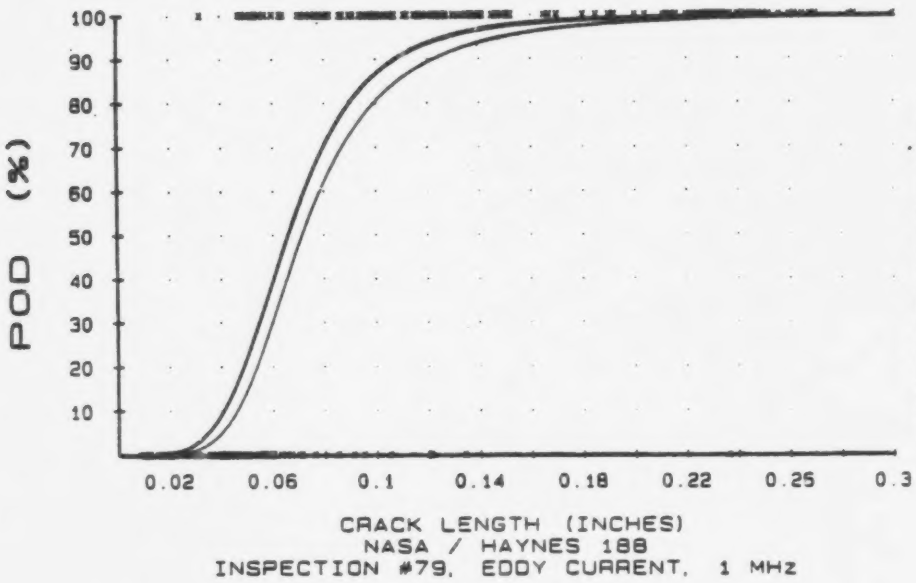
Figure B-77 Inspection #77 POD Curve



Inspection #78
Type III
Method A
Developer Rev. d
H188 Subset B
16 Panels
62 Cracks
98.4% Detection
7 False Calls

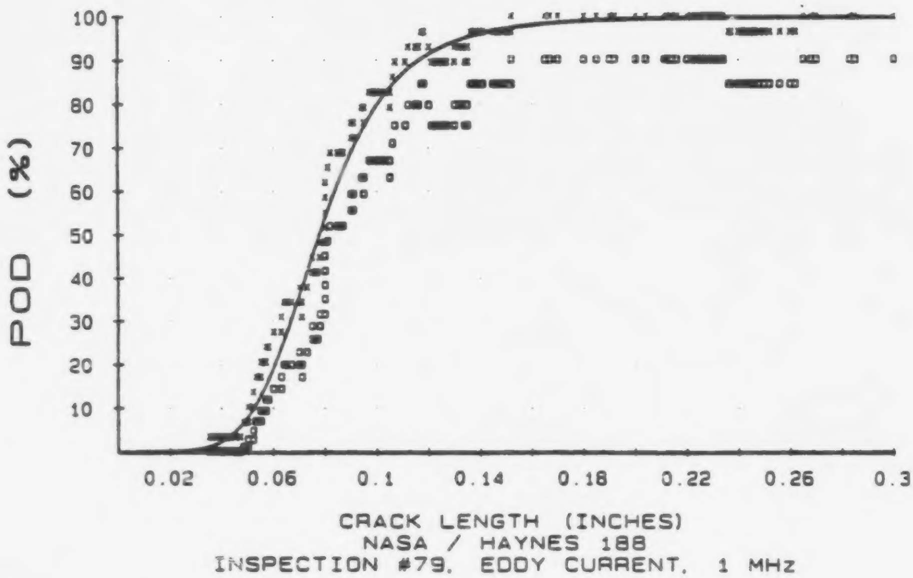
Maximum Likelihood Analysis

Figure B-78 Inspection #78 POD Curve



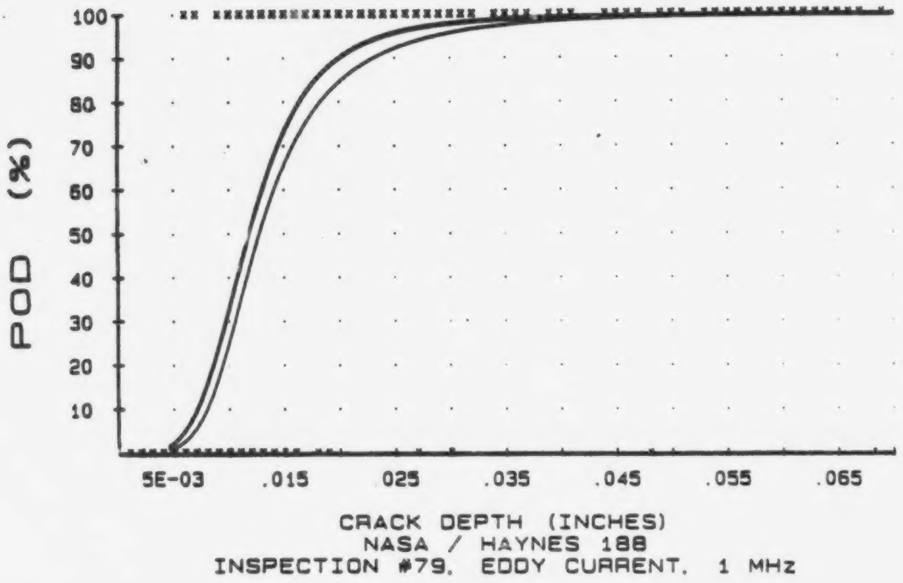
Inspection #79
Eddy Current
Hand Scan
Probe 1 MHz
Probe Dia 0.125"
Cal. Std. EDM
Size .042"x.010"
Haynes 188
102 Panels
284 Cracks
68.0% Detection
3 False Calls

Maximum Likelihood Analysis



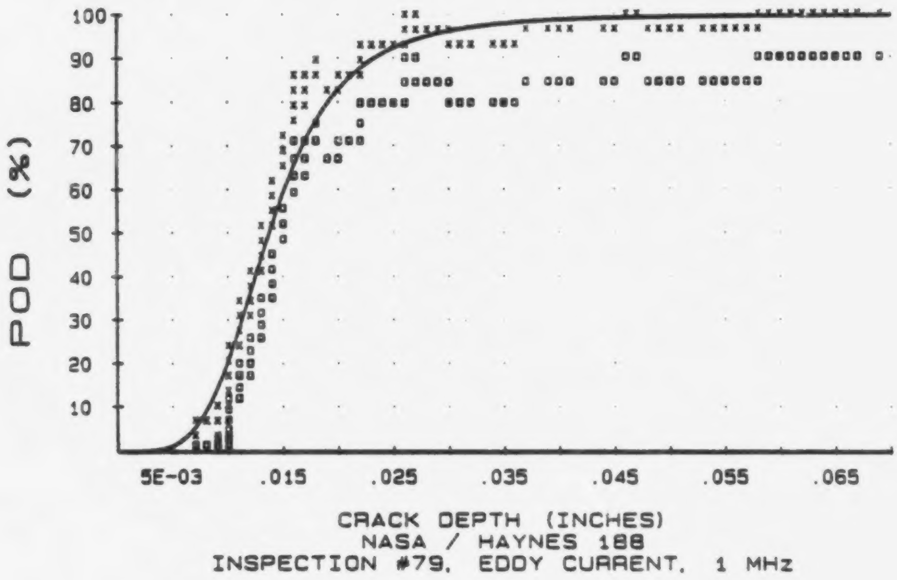
Moving Average Analysis

Figure B-79 Inspection #79 POD Curves (Crack Length)



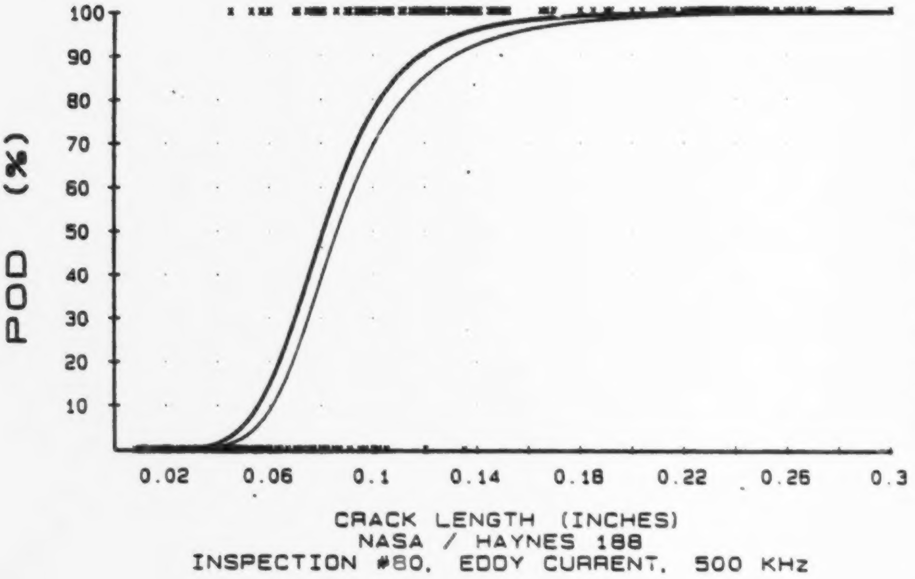
Inspection #79
Eddy Current
Hand Scan
Probe 1 MHz
Probe Dia 0.125"
Cal. Std. EDM
Size .042"x.010"
Haynes 188
102 Panels
284 Cracks
68.0% Detection
3 False Calls

Maximum Likelihood Analysis



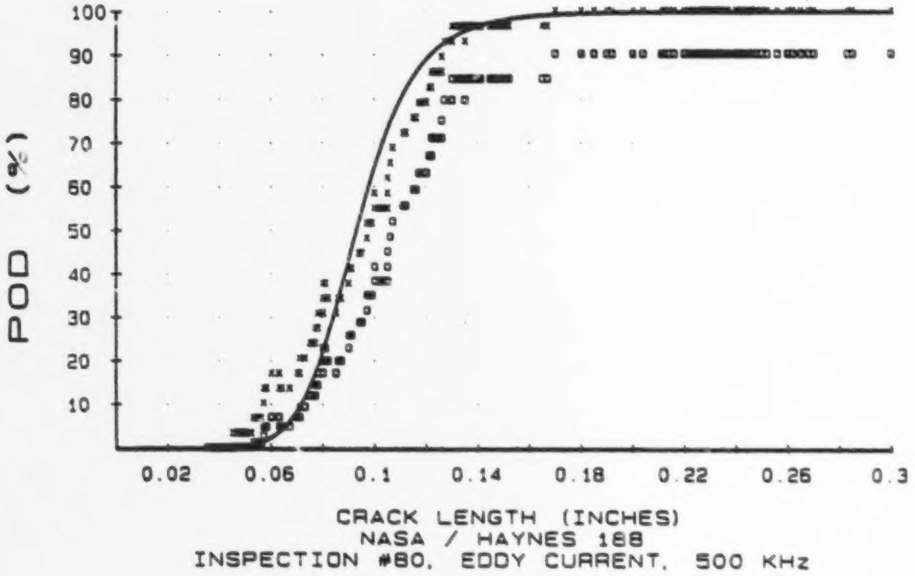
Moving Average Analysis

Figure B-80 Inspection #79 POD Curves (Crack Depth)



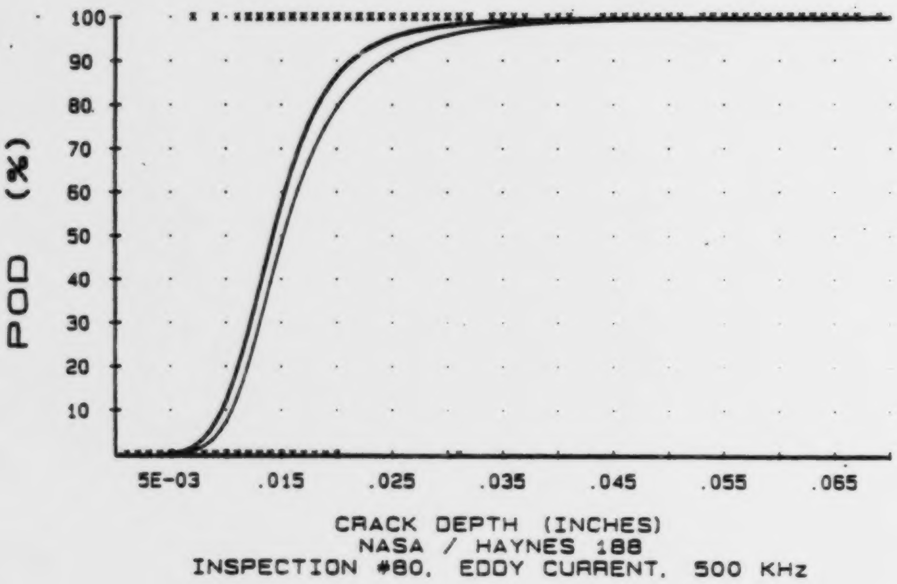
Inspection #80
Eddy Current
Hand Scan
Probe 500 kHz
Probe Dia 0.750"
Cal. Std. Crack
Size .080"x.010"
Haynes 188
102 Panels
284 Cracks
60.2% Detection
5 False Calls

Maximum Likelihood Analysis



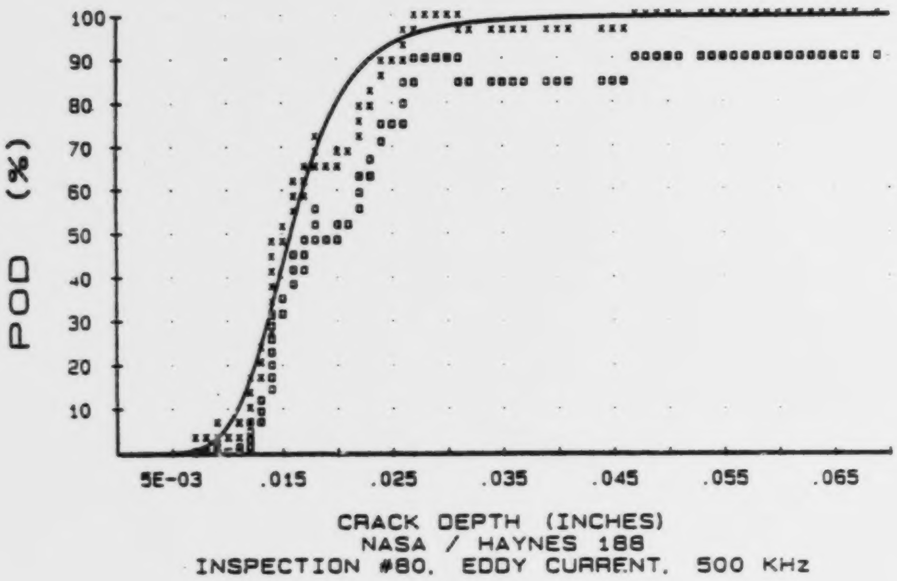
Moving Average Analysis

Figure B-81 Inspoction #80 POD Curves (Crack Length)



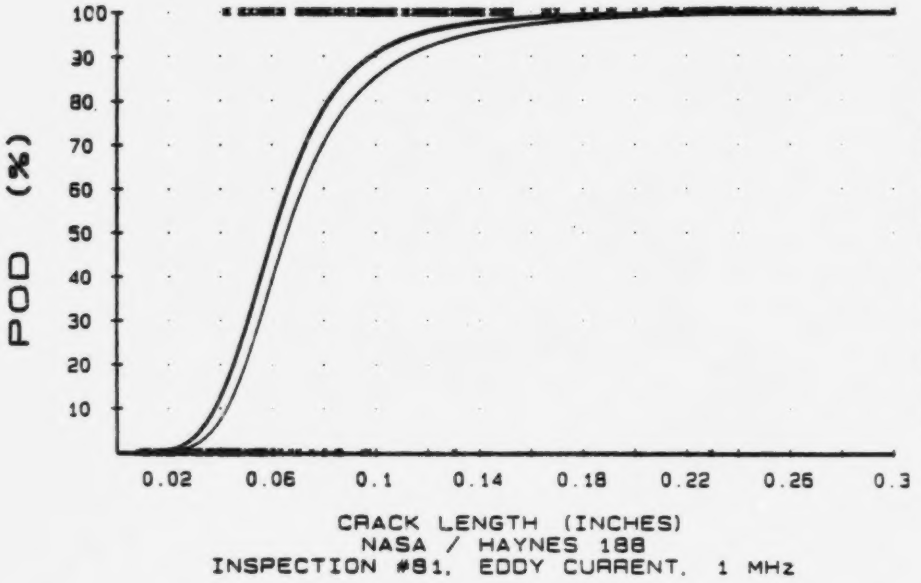
Inspection #80
Eddy Current
Hand Scan
Probe 500 kHz
Probe Dia 0.250"
Cal. Std. Crack
Size .080"x.010"
Haynes 188
102 Panels
284 Cracks
60.2% Detection
5 False Calls

Maximum Likelihood Analysis



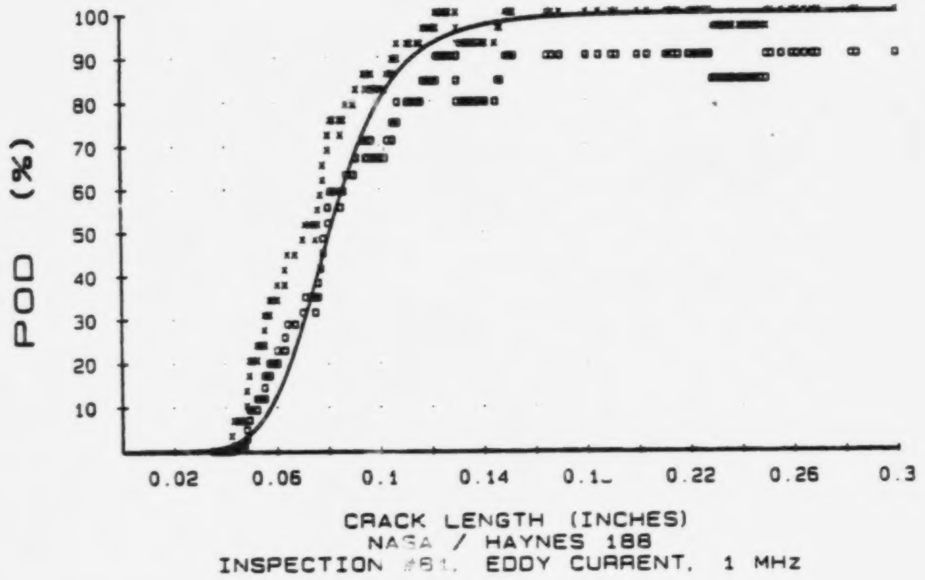
Moving Average Analysis

Figure B-82 Inspection #80 POD Curves (Crack Depth)



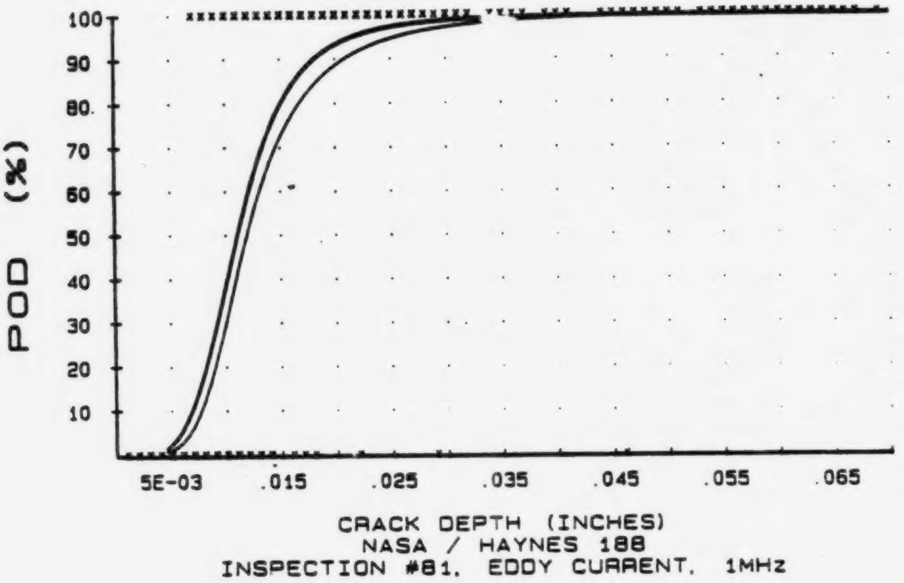
Inspection #81
Eddy Current
Hand Scan
Probe 1 MHz
Probe Dia 0.250"
Cal. Std. Crack
Size .080"x.010"
Haynes 188
102 Panels
284 Cracks
70.1% Detection
5 False Calls

Maximum Likelihood Analysis



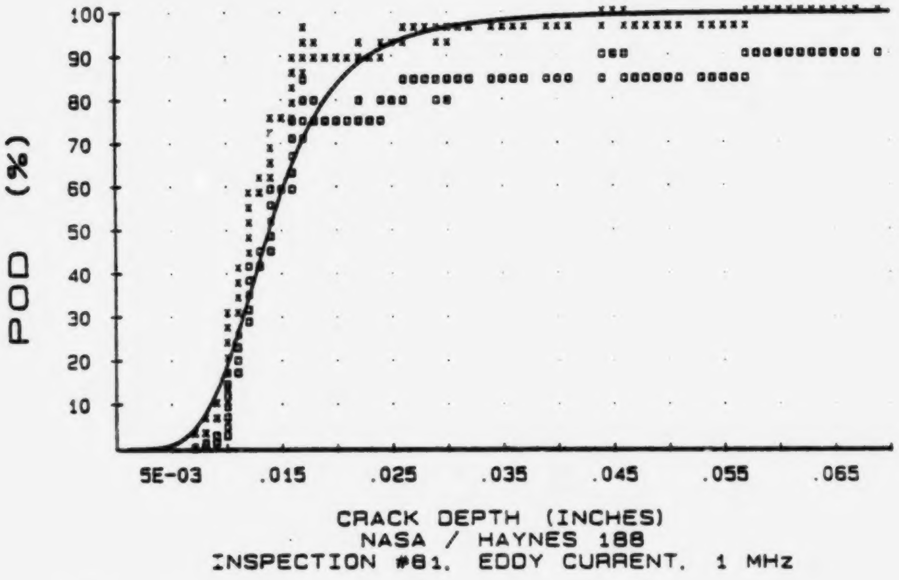
Moving Average Analysis

Figure B-83 Inspection #81 POD Curves (Crack Length)



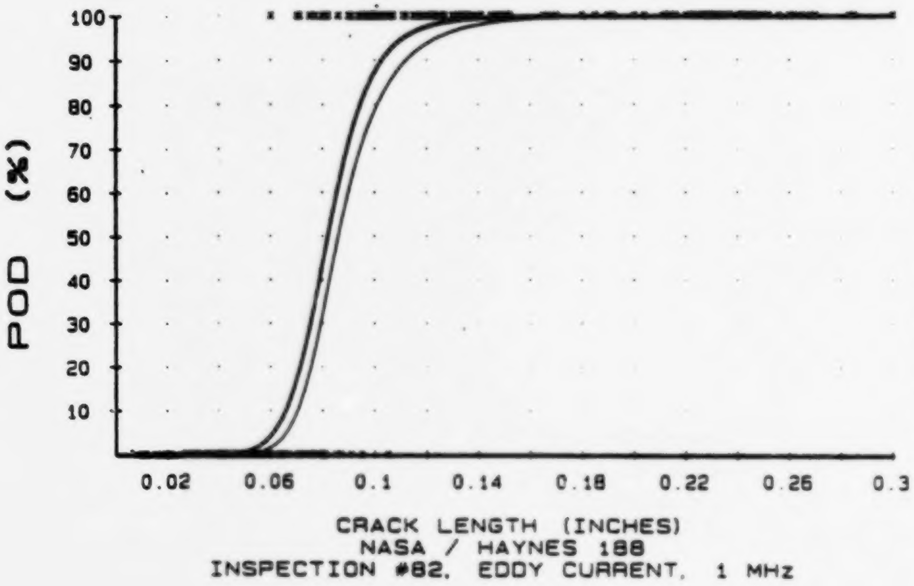
Inspection #81
Eddy Current
Hand Scan
Probe 1 MHz
Probe Dia 0.250"
Cal. Std. Crack
Size .080"x.010"
Haynes 188
102 Panels
284 Cracks
70.1% Detection
5 False Calls

Maximum Likelihood Analysis



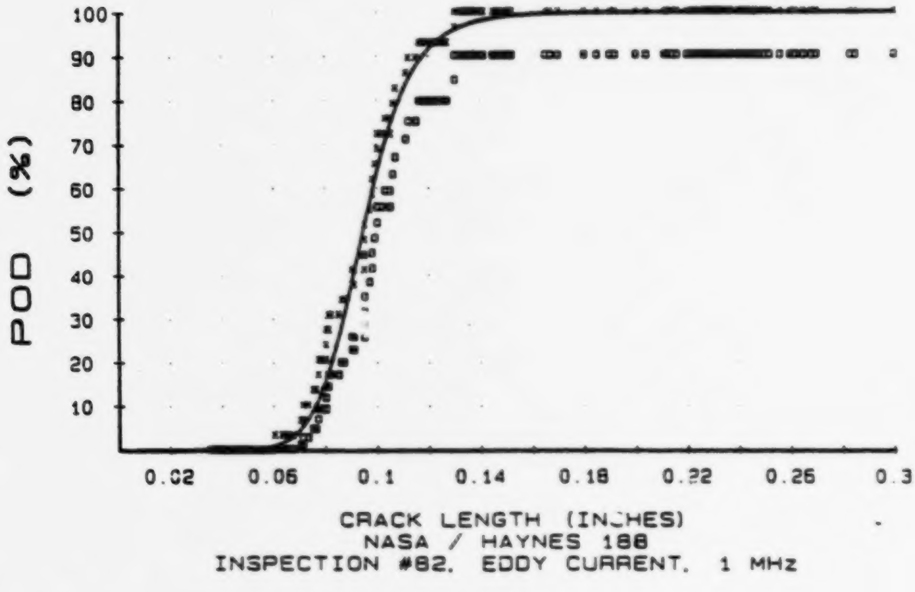
Moving Average Analysis

Figure B-84 Inspection #81 POD Curves (Crack Depth)



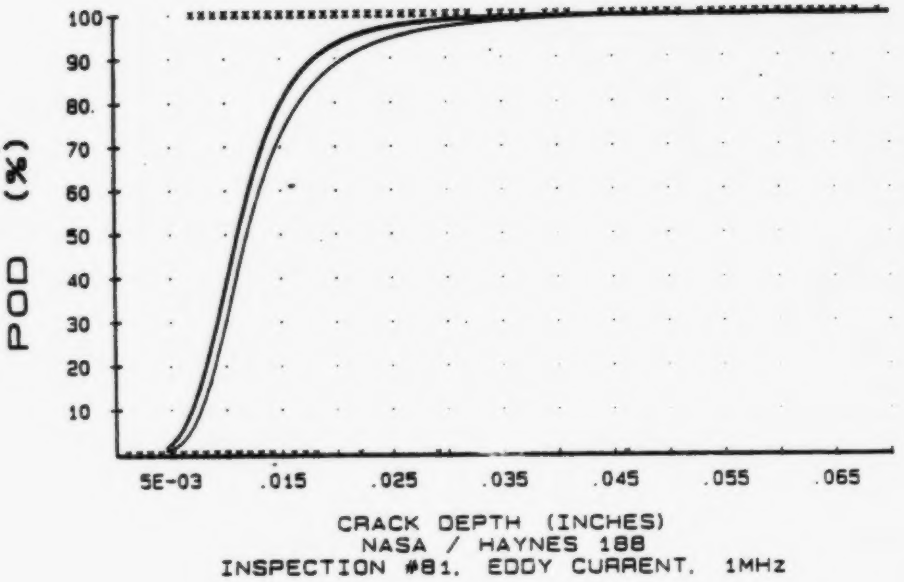
Inspection #82
Eddy Current
Automatic Scan
Probe 1 MHz
Probe Dia 0.125"
Cal. Std. Crack
Size .080"x.010"
Threshold 11 div.
Haynes 188
102 Panels
284 Cracks
62.7% Detection
7 False Calls

Maximum Likelihood Analysis



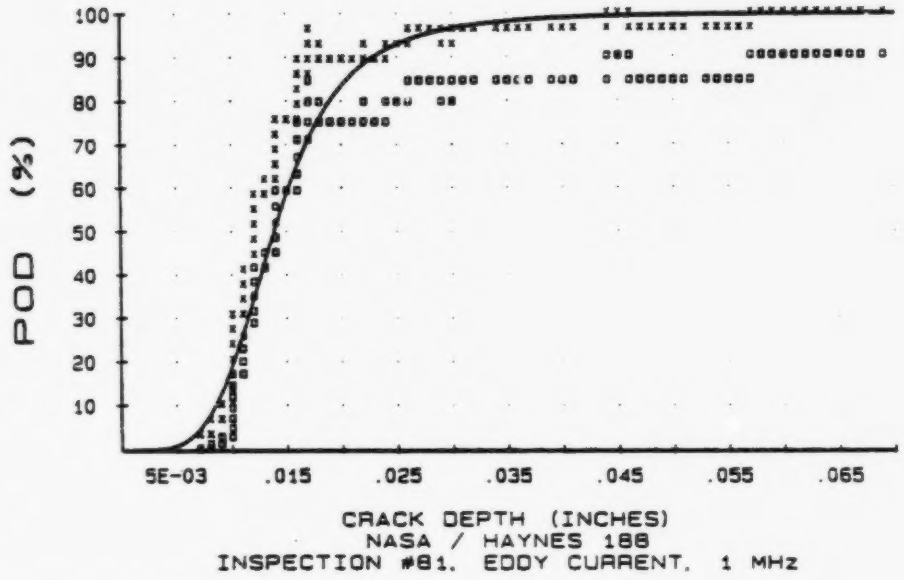
Moving Average Analysis

Figure B-85 Inspection #82 POD Curves (Crack Length)



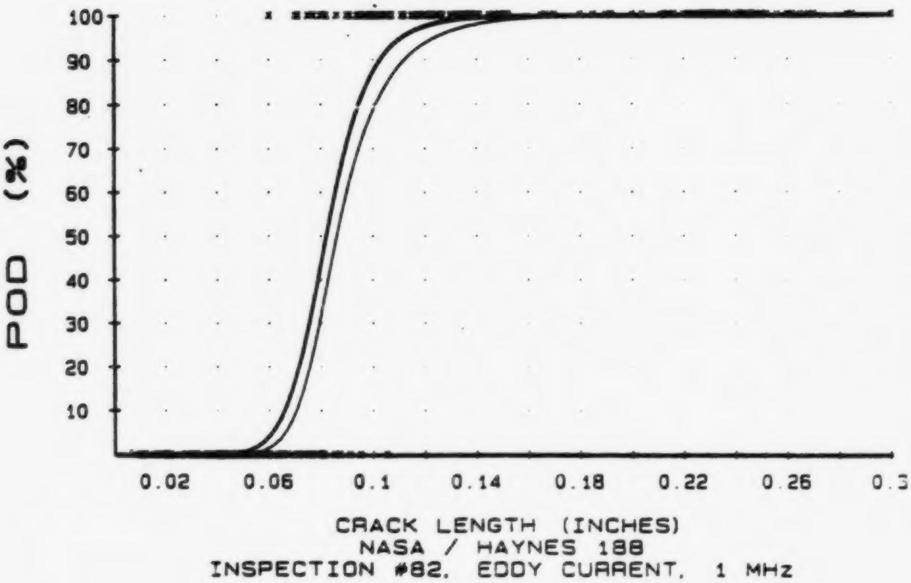
Inspection #81
Eddy Current
Hand Scan
Probe 1 MHz
Probe Dia 0.250"
Cal. Std. Crack
Size .080"x.010"
Haynes 188
102 Panels
284 Cracks
70.1% Detection
5 False Calls

Maximum Likelihood Analysis



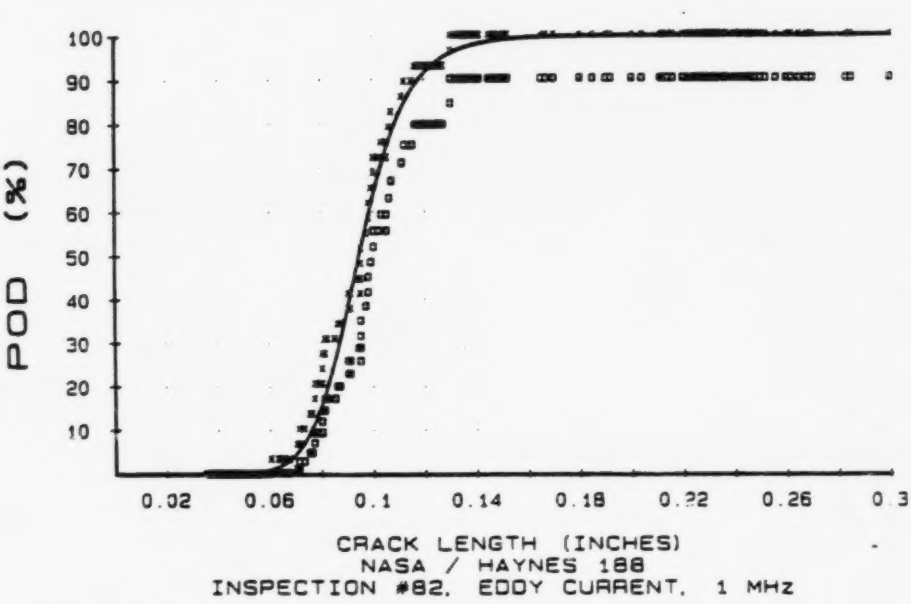
Moving Average Analysis

Figure B-84 Inspection #81 POD Curves (Crack Depth)



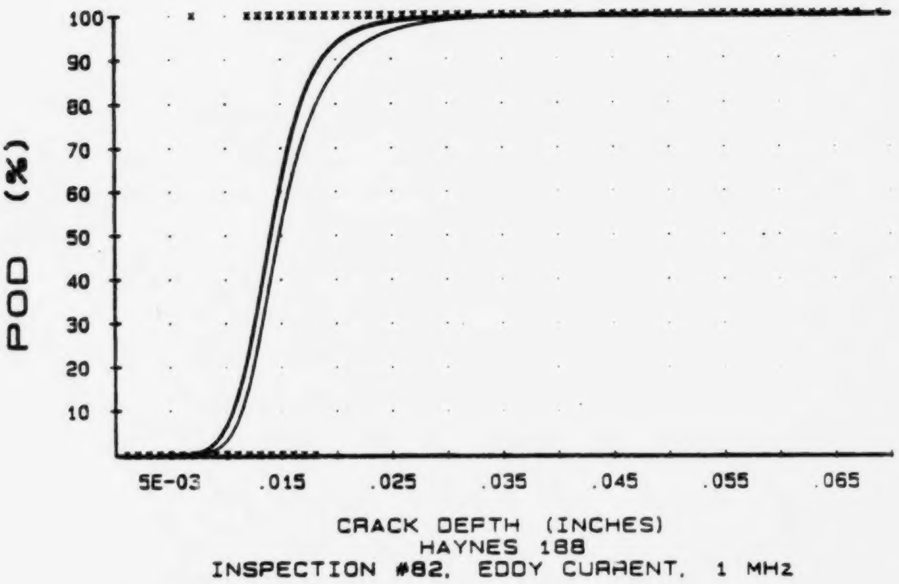
Inspection #82
Eddy Current
Automatic Scan
Probe 1 MHz
Probe Dia 0.125"
Cal. Std. Crack
Size .080"x.010"
Threshold 11 div.
Haynes 188
102 Panels
284 Cracks
62.7% Detection
7 False Calls

Maximum Likelihood Analysis



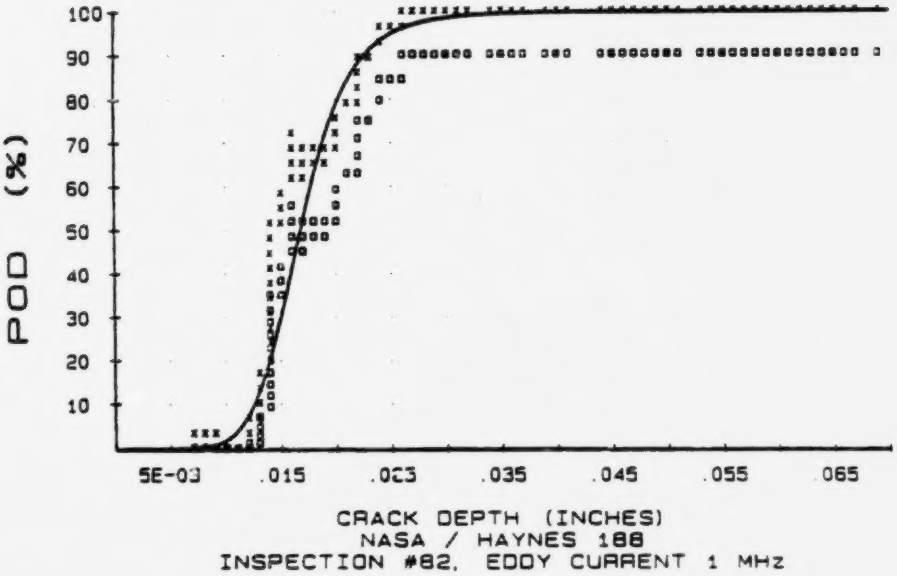
Moving Average Analysis

Figure B-65 Inspection #82 POD Curves (Crack Length)



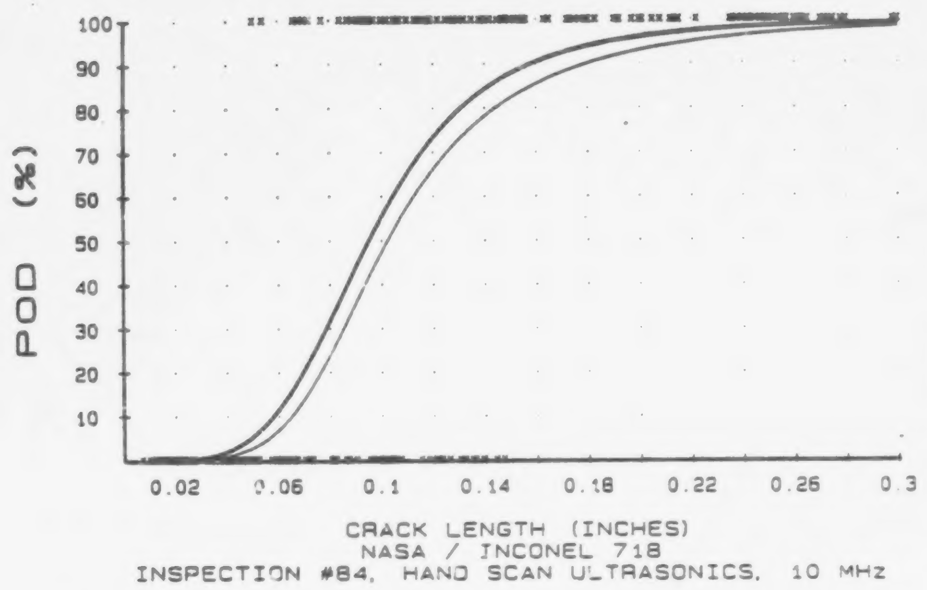
Inspection #82
Eddy Current
Automatic Scan
Probe 1 MHz
Probe Dia 0.125"
Cal. Std. Crack
Size .080"x.010"
Threshold 11 div.
Haynes 188
102 Panels
284 Cracks
62.7% Detection
7 False Calls

Maximum Likelihood Analysis



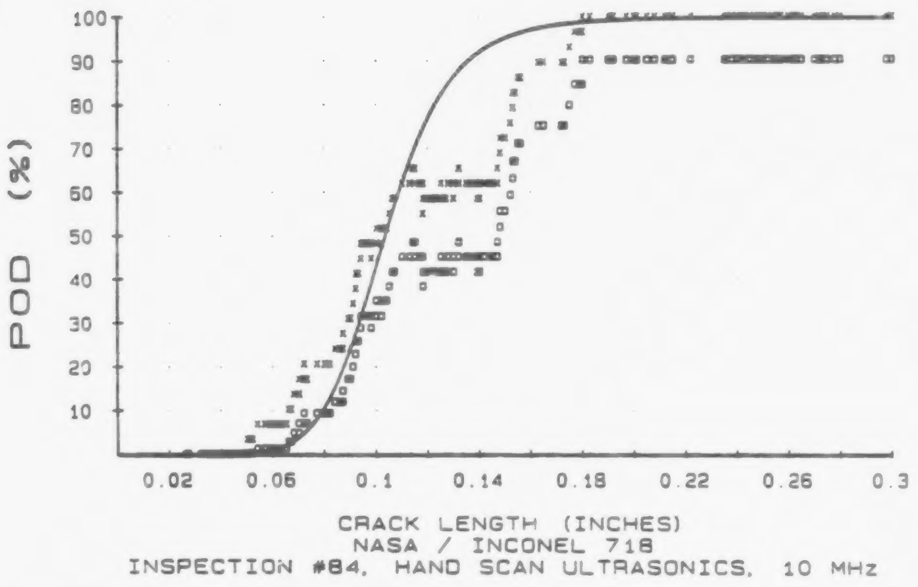
Moving Average Analysis

Figure B-86 Inspection #82 POD Curves (Crack Depth)



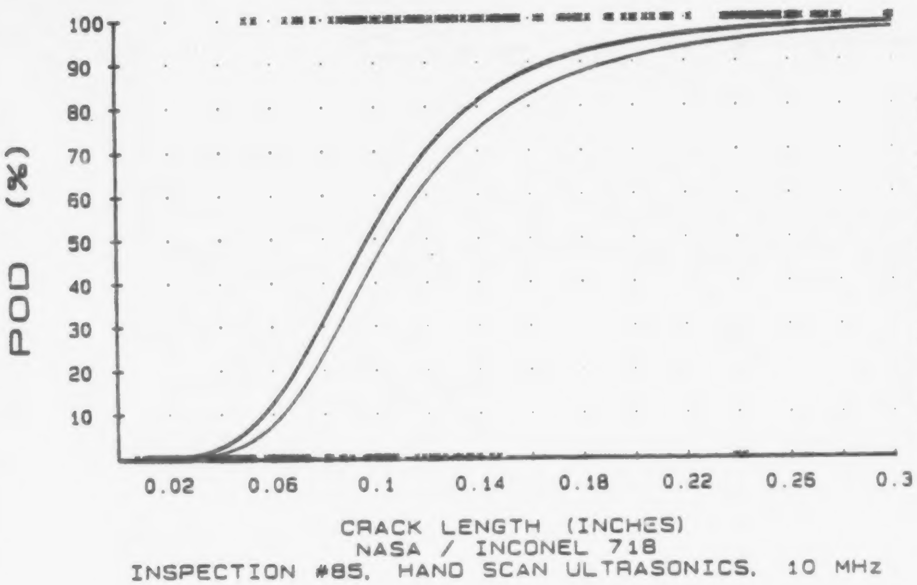
Inspection # 84
Ultrasonic
Hand Contact
Freq. 10 MHz
Refr angle 42 deg
Cal. Std. Crack
Size .073"x.010"
Threshold 90%
Inconel 718
110 Panels
281 Cracks
53.7% Detection
0 False Calls

Maximum Likelihood Analysis



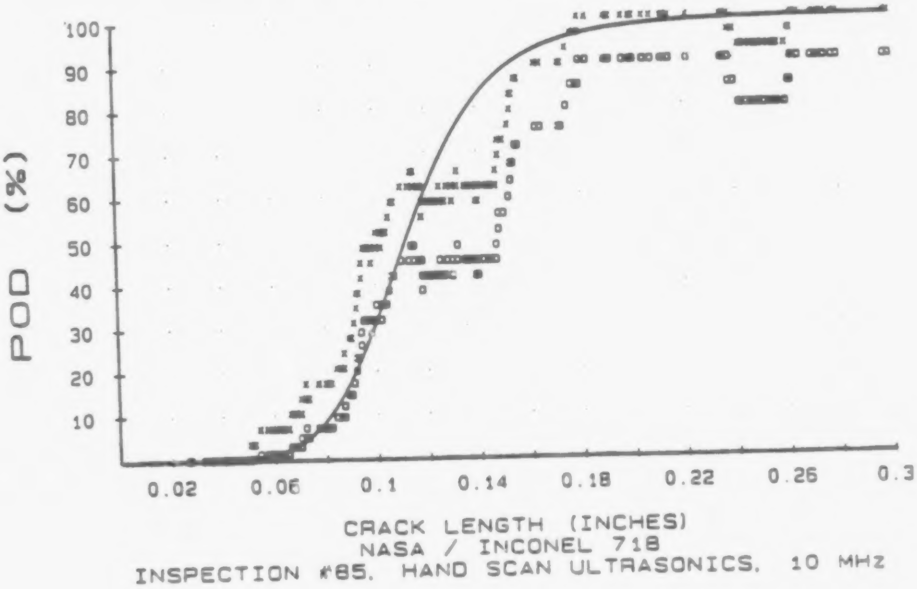
Moving Average Analysis

Figure B-88 Inspection #84 POD Curves



Inspection #85
Ultrasonic
Hand Contact
Freq. 10 MHz
Refr angle 42 deg
Cal. Std. Crack
Size .073" x .010"
Threshold 90%
Inconel 718
110 Panels
281 Cracks
45.9% Detection
1 False Call

Maximum Likelihood Analysis



Moving Average Analysis

Figure B-89 Inspection #85 POD Curves

C.0 APPENDIX C
NDE ASSESSMENT INSPECTION SEQUENCE DATA FILES

This appendix presents the inspection result data files for each inspection sequence completed during the NDE assessment program. The data files consist of data pairs for each crack inspected. The data pairs include the crack length and the inspection outcome where a "1" represents detection, a "0" represents a failure to detect and a "-1" indicates that the paired crack was not inspected.

For the automated scan eddy current and ultrasonic inspection sequences (Inspections #82-#85), the actual inspection signal is paired with the crack dimension rather than using values of 0 and 1 to represent the inspection outcome.

The results for the eddy current inspection sequences (Inspections #80-#82) have been listed by both crack length and estimated crack depth.

INSPECTION # 1

NUMBER OF POINTS :284

.008	0	.045	1	.087	0	.130	1	.227	1
.010	0	.046	1	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	0	.228	1
.011	0	.048	1	.091	1	.133	1	.229	0
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	0	.095	1	.135	1	.232	1
.016	0	.050	1	.095	0	.135	1	.233	1
.018	0	.050	1	.096	1	.135	1	.233	1
.018	1	.052	1	.096	0	.135	1	.234	0
.019	0	.052	0	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	0	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	1	.055	0	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	0
.025	0	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	0	.140	1	.242	1
.028	0	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	0	.141	1	.245	1
.030	0	.060	0	.105	1	.145	1	.245	1
.031	1	.063	0	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	1	.107	1	.147	1	.246	1
.035	0	.065	0	.111	1	.149	0	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	1	.250	1
.036	0	.071	0	.115	1	.152	1	.250	0
.038	0	.071	0	.115	1	.152	1	.250	1
.038	1	.073	0	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	0	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	0	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	0
.045	1	.086	0	.130	1	.226	1		

INSPECTION # 2 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	0	.227	1
.010	0	.046	0	.090	0	.132	1	.228	0
.010	0	.046	0	.090	1	.133	1	.228	0
.010	0	.047	0	.091	0	.133	1	.228	0
.011	0	.048	0	.091	0	.133	0	.229	0
.012	0	.048	1	.094	1	.134	0	.230	1
.012	0	.049	0	.095	1	.135	0	.231	0
.015	0	.049	0	.095	0	.135	1	.232	0
.016	0	.050	0	.095	0	.135	0	.233	1
.018	0	.050	0	.095	0	.135	0	.233	0
.018	0	.052	1	.095	0	.135	1	.234	0
.019	0	.052	0	.097	0	.135	0	.234	0
.020	0	.053	1	.097	0	.136	0	.236	0
.020	0	.054	0	.097	0	.136	1	.236	0
.021	0	.055	1	.098	0	.137	0	.237	0
.022	0	.055	0	.098	0	.137	1	.237	0
.025	0	.055	0	.099	0	.137	0	.240	1
.025	0	.055	0	.100	1	.138	0	.240	0
.025	0	.056	0	.100	1	.138	0	.240	1
.025	0	.057	1	.100	0	.140	0	.241	0
.026	1	.057	0	.102	1	.140	0	.242	0
.028	0	.058	0	.103	0	.140	1	.242	0
.028	1	.060	1	.105	0	.141	0	.243	1
.030	1	.060	1	.105	0	.141	1	.245	0
.030	0	.060	0	.105	1	.145	1	.245	1
.031	0	.063	0	.105	0	.145	1	.245	1
.032	0	.063	0	.106	0	.146	1	.246	0
.035	0	.063	0	.107	0	.147	0	.246	0
.035	0	.064	1	.107	0	.147	0	.246	0
.035	0	.065	0	.111	0	.149	0	.248	1
.035	0	.067	0	.111	1	.150	0	.248	0
.035	0	.070	0	.111	1	.151	1	.248	0
.036	0	.070	1	.112	1	.151	0	.250	1
.036	0	.071	0	.115	0	.152	0	.250	0
.038	0	.071	0	.115	0	.152	0	.250	1
.038	0	.073	0	.116	1	.165	0	.252	0
.038	0	.075	1	.117	0	.167	1	.256	0
.038	0	.075	0	.118	0	.170	1	.260	1
.038	1	.076	0	.120	1	.170	0	.260	0
.039	0	.076	0	.120	1	.180	0	.262	0
.040	1	.077	0	.121	1	.180	1	.262	0
.040	0	.077	0	.122	0	.185	1	.265	1
.040	0	.078	1	.122	0	.185	0	.265	1
.040	0	.078	1	.122	0	.190	0	.268	0
.040	1	.080	1	.123	0	.190	1	.268	0
.040	0	.080	0	.123	1	.192	0	.270	0
.041	0	.080	0	.123	0	.200	1	.270	1
.042	0	.080	1	.125	1	.204	0	.283	1
.042	0	.080	0	.126	1	.211	0	.285	0
.042	0	.080	0	.126	0	.212	0	.300	1
.043	1	.081	0	.127	0	.214	0	.301	0
.043	1	.081	1	.130	0	.216	1	.310	1
.043	0	.082	0	.130	0	.220	1	.315	0
.045	0	.085	0	.130	1	.222	0	.330	0
.045	0	.085	0	.130	0	.223	1	.347	1
.045	1	.085	0	.130	0	.225	0	.350	0
.045	1	.086	0	.130	1	.226	1		

INSPECTION # 3 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	0	.227	1
.010	0	.046	0	.090	0	.132	1	.228	1
.010	0	.046	0	.090	1	.133	1	.228	0
.010	0	.047	0	.091	0	.133	0	.228	0
.011	0	.048	0	.091	0	.133	0	.229	0
.012	0	.048	1	.094	1	.134	0	.230	1
.012	0	.049	0	.095	1	.135	0	.231	1
.015	0	.049	0	.095	0	.135	1	.232	0
.016	0	.050	0	.095	0	.135	0	.233	0
.018	0	.050	1	.095	0	.135	0	.233	0
.018	0	.052	1	.095	0	.135	0	.234	0
.019	0	.052	0	.097	0	.135	1	.234	0
.020	0	.053	0	.097	1	.136	0	.236	0
.020	0	.054	0	.097	0	.136	1	.236	0
.021	0	.055	0	.098	0	.137	1	.237	1
.022	0	.055	0	.098	0	.137	1	.237	1
.025	0	.055	0	.099	0	.137	1	.240	1
.025	0	.055	0	.100	0	.138	0	.240	0
.025	0	.056	0	.100	1	.138	0	.240	1
.025	0	.057	1	.100	0	.140	0	.241	1
.026	0	.057	0	.102	1	.140	0	.242	1
.028	0	.058	0	.103	0	.140	1	.242	0
.028	1	.060	1	.105	1	.141	0	.243	1
.030	0	.060	1	.105	0	.141	1	.245	1
.030	0	.060	0	.105	1	.145	1	.245	1
.031	0	.063	0	.105	0	.145	1	.245	1
.032	0	.063	0	.106	0	.146	1	.246	0
.035	0	.063	1	.107	0	.147	0	.246	0
.035	1	.064	0	.107	0	.147	0	.246	0
.035	0	.065	0	.111	1	.149	0	.248	0
.035	0	.067	0	.111	0	.150	1	.248	0
.035	0	.070	1	.111	1	.151	1	.248	0
.036	0	.070	0	.112	1	.151	0	.250	0
.036	0	.071	0	.115	0	.152	1	.250	0
.038	0	.071	0	.115	0	.152	1	.250	1
.038	0	.073	0	.116	0	.165	1	.252	0
.038	0	.075	0	.117	0	.167	1	.256	0
.038	0	.075	0	.118	1	.170	1	.260	1
.038	0	.076	0	.120	1	.170	1	.260	0
.039	1	.076	0	.120	1	.180	0	.262	0
.040	0	.077	1	.121	1	.180	1	.262	0
.040	0	.077	0	.122	0	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	0
.040	1	.078	0	.122	0	.190	1	.268	0
.040	0	.080	0	.123	0	.190	0	.268	0
.040	0	.080	0	.123	1	.192	0	.270	0
.041	0	.080	0	.123	0	.200	1	.270	1
.042	0	.080	0	.125	1	.204	0	.283	1
.042	0	.080	0	.126	1	.211	0	.285	1
.042	0	.080	0	.126	0	.212	0	.300	1
.043	1	.081	0	.127	0	.214	1	.301	0
.043	0	.081	0	.130	0	.216	1	.310	1
.043	0	.082	1	.130	0	.220	0	.315	1
.045	0	.085	0	.130	0	.222	1	.330	0
.045	0	.085	0	.130	0	.223	1	.347	1
.045	1	.085	1	.130	0	.225	0	.350	0
.045	0	.086	0	.130	1	.226	1		

INSPECTION # 4 NUMBER OF POINTS :281

.007	0	.044	0	.094	0	.142	1	.236	1
.007	0	.045	0	.094	1	.144	0	.238	0
.010	0	.046	1	.095	1	.144	0	.238	0
.011	0	.047	0	.095	1	.145	1	.240	1
.012	0	.047	0	.096	1	.145	0	.240	1
.012	0	.048	0	.097	0	.147	0	.242	0
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	0	.098	0	.147	1	.242	1
.013	0	.051	0	.100	0	.148	1	.243	1
.014	0	.052	0	.100	0	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	0	.102	0	.148	1	.247	0
.015	0	.057	1	.102	0	.150	0	.247	1
.016	0	.057	0	.102	0	.150	1	.248	1
.016	0	.057	0	.103	1	.152	1	.249	1
.017	0	.057	0	.104	0	.152	1	.250	1
.017	0	.059	0	.105	0	.152	1	.250	1
.018	0	.060	0	.105	0	.153	0	.252	0
.019	0	.060	0	.105	1	.153	1	.252	0
.019	0	.060	0	.106	0	.153	0	.254	1
.020	0	.062	1	.107	0	.154	0	.255	1
.020	0	.062	0	.107	0	.155	0	.255	1
.020	0	.063	0	.110	0	.155	0	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	0	.163	1	.256	1
.021	0	.065	0	.115	0	.163	1	.256	1
.022	0	.066	0	.115	1	.165	1	.257	0
.022	0	.066	0	.117	0	.172	0	.257	0
.022	0	.067	0	.118	1	.173	1	.257	0
.023	0	.068	0	.118	0	.173	0	.260	0
.023	0	.070	0	.118	0	.175	1	.260	0
.025	0	.070	0	.118	1	.177	0	.261	1
.026	0	.070	1	.119	0	.179	1	.262	1
.026	0	.072	1	.121	0	.180	1	.262	1
.026	0	.072	0	.122	1	.180	0	.262	0
.027	0	.072	0	.122	0	.183	1	.263	1
.027	0	.073	0	.123	0	.190	0	.265	0
.032	0	.073	0	.125	0	.191	1	.265	0
.033	0	.073	0	.125	0	.192	0	.270	1
.034	0	.077	0	.126	0	.192	0	.270	1
.035	0	.077	0	.127	1	.197	0	.272	1
.035	0	.080	0	.128	1	.197	0	.272	1
.035	0	.080	1	.130	1	.200	1	.273	1
.036	0	.080	0	.130	1	.200	0	.275	0
.037	0	.081	0	.132	1	.201	0	.275	0
.038	0	.082	0	.132	0	.203	1	.278	1
.039	1	.084	1	.132	0	.205	0	.280	1
.040	0	.086	1	.135	1	.206	0	.298	1
.040	0	.087	0	.135	0	.208	1	.300	1
.041	1	.087	0	.136	0	.212	1	.302	1
.042	0	.087	0	.138	0	.213	1	.315	0
.042	0	.089	1	.139	0	.215	0	.365	0
.042	0	.090	1	.139	0	.215	1	.422	1
.042	0	.091	0	.140	0	.215	1		
.043	0	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	0	.235	1		
.043	0	.093	1	.142	0	.236	1		

INSPECTION # 5

NUMBER OF POINTS :281

.007	0
.007	0
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.011	0
.012	0
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INSPECTION #6 NUMBER OF POINTS :281

.007	0	.044	0	.094	1	.142	1	.236	0
.007	0	.045	0	.094	1	.144	0	.238	1
.010	0	.046	0	.095	1	.144	1	.238	0
.011	0	.047	0	.095	0	.145	1	.240	1
.012	0	.047	0	.096	1	.145	1	.240	1
.012	0	.048	0	.097	0	.147	1	.242	0
.012	0	.050	1	.098	1	.147	0	.242	1
.013	0	.050	0	.098	1	.147	1	.242	0
.013	0	.051	0	.100	0	.148	1	.243	1
.014	0	.052	0	.100	0	.148	0	.245	1
.014	0	.054	1	.100	1	.148	1	.245	0
.015	0	.057	0	.102	1	.148	1	.247	1
.015	0	.057	0	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	0
.016	0	.057	0	.103	1	.152	1	.249	1
.017	0	.057	0	.104	0	.152	1	.250	1
.017	0	.059	0	.105	0	.152	0	.250	1
.018	0	.060	0	.105	0	.153	1	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	0	.254	1
.020	0	.062	1	.107	1	.154	1	.255	0
.020	0	.062	0	.107	1	.155	1	.255	1
.020	0	.063	0	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	0	.163	1	.256	1
.021	0	.065	0	.115	0	.163	0	.256	1
.022	0	.066	0	.115	0	.165	1	.257	0
.022	0	.066	0	.117	0	.172	0	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	0	.260	1
.023	0	.070	1	.118	0	.175	1	.260	1
.025	0	.070	1	.118	0	.177	1	.261	1
.026	0	.070	1	.119	0	.179	1	.262	1
.026	0	.072	0	.121	0	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	0	.122	1	.183	1	.263	1
.027	0	.073	0	.123	1	.190	1	.265	1
.032	0	.073	1	.125	0	.191	1	.265	1
.033	0	.073	0	.125	0	.192	1	.270	1
.034	0	.077	1	.126	1	.192	1	.270	0
.035	0	.077	1	.127	0	.197	1	.272	1
.035	0	.080	0	.128	1	.197	1	.272	1
.035	0	.080	1	.130	0	.200	1	.273	1
.036	1	.080	0	.130	1	.200	1	.275	1
.037	0	.081	0	.132	1	.201	0	.275	0
.038	0	.082	0	.132	1	.203	0	.278	1
.039	0	.084	0	.132	0	.205	1	.280	1
.040	0	.086	0	.135	1	.206	1	.298	1
.040	0	.087	1	.135	1	.208	1	.300	1
.041	0	.087	0	.136	1	.212	1	.302	1
.042	0	.087	0	.138	1	.213	1	.315	1
.042	0	.089	1	.139	1	.215	0	.365	0
.042	0	.090	1	.139	1	.215	1	.422	1
.042	0	.091	0	.140	0	.215	1		
.043	0	.092	1	.140	1	.222	1		
.043	1	.092	1	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION #7

NUMBER OF POINTS :284

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INSPECTION # 8 **NUMBER OF POINTS :284**

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.010	0	.046	0	.090	0	.133	1	.228	0
.010	0	.047	0	.091	0	.133	0	.228	0
.011	0	.048	0	.091	0	.133	0	.229	0
.012	0	.048	0	.094	1	.134	0	.230	1
.012	0	.049	0	.095	0	.135	0	.231	1
.015	0	.049	0	.095	0	.135	0	.232	0
.016	0	.050	0	.095	0	.135	0	.233	1
.018	0	.050	0	.095	0	.135	0	.233	0
.018	0	.052	0	.095	0	.135	1	.234	0
.019	0	.052	0	.097	0	.135	1	.234	0
.020	0	.053	1	.097	0	.136	0	.236	0
.020	0	.054	0	.097	0	.136	1	.236	0
.021	0	.055	0	.098	0	.137	1	.237	0
.022	0	.055	0	.098	0	.137	1	.237	0
.025	0	.055	0	.099	0	.137	1	.240	0
.025	0	.055	0	.100	0	.138	0	.240	1
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.026	0	.057	0	.102	0	.140	0	.242	0
.028	0	.058	0	.103	0	.140	0	.242	0
.028	0	.060	0	.105	0	.141	0	.243	1
.030	0	.060	0	.105	0	.141	1	.245	0
.030	0	.060	0	.105	1	.145	0	.245	0
.031	0	.063	0	.105	0	.145	1	.245	0
.032	0	.063	0	.106	0	.146	0	.246	0
.035	0	.063	1	.107	0	.147	0	.246	0
.035	0	.064	0	.107	0	.147	0	.246	0
.035	0	.065	0	.111	0	.149	0	.248	1
.035	0	.067	0	.111	0	.150	0	.248	1
.035	0	.070	0	.111	0	.151	0	.248	0
.036	0	.070	0	.112	1	.151	0	.250	1
.036	0	.071	0	.115	0	.152	0	.250	0
.038	0	.071	0	.115	0	.152	1	.250	1
.038	0	.073	0	.116	0	.165	1	.252	0
.038	0	.075	0	.117	0	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	0
.038	0	.076	1	.120	0	.170	1	.260	0
.039	0	.076	0	.120	1	.180	0	.262	0
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.040	0	.077	0	.122	0	.185	1	.265	1
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.040	0	.078	0	.122	0	.190	0	.268	0
.040	0	.080	0	.123	0	.190	1	.268	0
.040	0	.080	0	.123	1	.192	0	.270	0
.041	0	.080	0	.123	0	.200	1	.270	1
.042	0	.080	1	.125	1	.204	0	.283	0
.042	0	.080	0	.126	0	.211	0	.285	0
.042	0	.080	0	.126	0	.212	1	.300	1
.043	0	.081	0	.127	0	.214	0	.301	0
.043	1	.081	0	.130	0	.216	0	.310	1
.043	0	.082	0	.130	1	.220	0	.315	1
.045	0	.085	0	.130	0	.222	1	.330	1
.045	0	.085	0	.130	0	.223	1	.347	1
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INSPECTION # 9

NUMBER OF POINTS :281

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INSPECTION # 10

NUMBER OF POINTS :284

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INSPECTION #11

NUMBER OF POINTS :281

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INSPECTION # 12 NUMBER OF POINTS :284

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INSPECTION # 13

NUMBER OF POINTS :281

.007	0	.044	1	.094	1	.142	1	.236	1
.007	0	.045	0	.094	1	.144	0	.238	1
.010	0	.046	1	.095	1	.144	0	.238	0
.011	0	.047	1	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	1	.240	1
.012	0	.048	0	.097	1	.147	0	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	0	.100	0	.148	1	.243	1
.014	0	.052	1	.100	0	.148	0	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	0	.102	1	.148	1	.247	0
.015	0	.057	1	.102	0	.150	1	.247	1
.016	0	.057	0	.102	1	.150	0	.248	1
.016	0	.057	0	.103	1	.152	1	.249	1
.017	1	.057	0	.104	0	.152	1	.250	1
.017	0	.059	0	.105	1	.152	1	.250	1
.018	0	.060	1	.105	0	.153	1	.252	0
.019	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	0	.106	1	.153	0	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	0	.155	1	.255	1
.020	0	.063	0	.110	0	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	0	.066	1	.115	1	.165	1	.257	1
.022	0	.066	0	.117	0	.172	0	.257	0
.022	0	.067	0	.118	1	.173	1	.257	0
.023	0	.068	1	.118	1	.173	1	.260	0
.023	0	.070	1	.118	1	.175	1	.260	0
.025	0	.070	1	.118	1	.177	0	.261	1
.026	0	.070	1	.119	1	.179	1	.262	1
.026	0	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	0	.262	1
.027	1	.072	1	.122	0	.183	1	.263	0
.027	0	.073	1	.123	0	.190	1	.265	1
.032	0	.073	0	.125	1	.191	1	.265	1
.033	0	.073	0	.125	0	.192	1	.270	1
.034	0	.077	1	.126	0	.192	1	.270	1
.035	0	.077	1	.127	1	.197	0	.272	1
.035	0	.080	0	.128	1	.197	1	.272	1
.035	0	.080	1	.130	1	.200	1	.273	1
.036	1	.080	1	.130	1	.200	1	.275	0
.037	0	.081	0	.132	1	.201	0	.275	0
.038	0	.082	0	.132	0	.203	1	.278	1
.039	0	.084	0	.132	1	.205	0	.280	1
.040	1	.086	1	.135	1	.206	0	.298	1
.040	1	.087	1	.135	0	.208	1	.300	0
.041	0	.087	0	.136	0	.212	1	.302	1
.042	0	.087	0	.138	0	.213	1	.315	0
.042	1	.089	0	.139	1	.215	1	.365	1
.042	0	.090	1	.139	0	.215	1	.422	1
.042	0	.091	0	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	1	.092	1	.140	0	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION # 14 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	0
.010	0	.047	0	.091	1	.133	0	.228	1
.011	0	.048	0	.091	1	.133	1	.229	0
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	0	.095	1	.135	1	.231	1
.015	0	.049	0	.095	1	.135	1	.232	1
.016	0	.050	1	.095	0	.135	0	.233	1
.018	0	.050	0	.095	1	.135	0	.233	1
.018	0	.052	1	.095	1	.135	1	.234	0
.019	0	.052	0	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	0	36	1
.020	0	.054	1	.097	1	.136	0	.236	1
.021	0	.055	0	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	1	.099	0	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	0
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	1	.100	1	.140	1	.241	0
.026	0	.057	1	.102	0	.140	0	.242	1
.028	0	.058	0	.103	1	.140	0	.242	1
.028	0	.060	1	.105	1	.141	1	.243	1
.030	0	.060	1	.105	0	.141	1	.245	1
.030	1	.060	0	.105	1	.145	0	.245	1
.031	0	.063	0	.105	0	.145	1	.245	1
.032	0	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	0	.147	0	.246	1
.035	0	.064	0	.107	0	.147	0	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	0	.151	1	.248	1
.036	0	.070	1	.112	1	.151	0	.250	1
.036	0	.071	0	.115	1	.152	1	.250	0
.038	0	.071	0	.115	0	.152	1	.250	1
.038	0	.073	1	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	1	.076	1	.120	1	.180	1	.262	0
.040	0	.077	0	.121	1	.180	1	.262	1
.040	0	.077	0	.122	1	.185	1	.265	0
.040	0	.078	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	0	.190	1	.268	1
.040	0	.080	1	.123	0	.190	1	.268	1
.040	0	.080	1	.123	1	.192	0	.270	1
.041	0	.080	0	.123	1	.200	1	.270	1
.042	0	.080	1	.125	0	.204	1	.283	1
.042	0	.080	0	.126	1	.211	0	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	0	.127	0	.214	1	.301	1
.043	1	.081	1	.130	0	.216	1	.310	1
.043	0	.082	1	.130	1	.220	0	.315	1
.045	0	.085	0	.130	1	.222	1	.330	0
.045	0	.085	0	.130	0	.223	1	.347	1
.045	1	.085	0	.130	0	.225	1	.350	1
.045	0	.086	1	.130	1	.226	1		

INSPECTION #15

NUMBER OF POINTS :284

.008	0
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INSPECTION # 16

NUMBER OF POINTS :284

.008	0	.045	1	.087	0	.130	1	.227	1
.010	0	.046	1	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	1	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	1	.135	1	.234	1
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	1	.055	1	.100	1	.138	1	.240	1
.025	0	.056	1	.100	1	.138	1	.240	1
.025	0	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	0	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	1	.141	1	.245	1
.030	0	.060	0	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	1	.107	1	.147	1	.246	1
.035	1	.065	1	.111	1	.149	1	.248	1
.035	0	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	1	.250	1
.036	0	.071	1	.115	1	.152	0	.250	1
.038	0	.071	0	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	1	.085	1	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 17 NUMBER OF POINTS :284

.008	0	.045	0	.087	1	.130	1	.227	0
.010	0	.046	1	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	0
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	0	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	0	.095	1	.135	0	.232	1
.016	0	.050	1	.095	1	.135	0	.233	0
.018	0	.050	1	.095	1	.135	1	.233	1
.018	0	.052	0	.095	1	.135	1	.234	1
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	0	.098	1	.137	1	.237	1
.022	0	.055	1	.098	1	.137	1	.237	1
.025	0	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	0	.242	1
.028	0	.058	1	.103	1	.140	1	.242	1
.028	0	.060	1	.105	1	.141	1	.243	1
.030	0	.060	1	.105	0	.141	1	.245	1
.030	1	.060	0	.105	1	.145	1	.245	1
.031	0	.063	1	.105	1	.145	1	.245	1
.032	0	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	0	.246	1
.035	0	.064	1	.107	1	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	0	.070	0	.112	1	.151	1	.250	1
.036	1	.071	0	.115	0	.152	1	.250	1
.038	1	.071	1	.115	1	.152	1	.250	1
.038	0	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	0	.118	1	.170	1	.260	1
.038	0	.076	1	.120	0	.170	1	.260	1
.039	0	.076	0	.120	0	.180	1	.262	1
.040	1	.077	1	.121	1	.180	1	.262	1
.040	0	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	0	.190	1	.268	1
.040	0	.080	1	.123	1	.190	1	.268	1
.040	0	.080	1	.123	1	.192	1	.270	1
.041	1	.080	0	.123	1	.200	1	.270	1
.042	1	.080	0	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	0	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	1	.085	1	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	0	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 18 NUMBER OF POINTS :281

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.300	0
.302	1
.315	1
.365	1
.422	1

INSPECTION #19 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	0	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	0	.090	1	.133	1	.228	1
.010	0	.047	0	.091	0	.133	1	.228	1
.011	0	.048	1	.091	0	.133	0	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	0	.095	1	.135	1	.231	1
.015	0	.049	0	.095	1	.135	1	.232	1
.016	0	.050	0	.095	1	.135	0	.233	1
.018	0	.050	0	.095	0	.135	1	.233	1
.018	0	.052	1	.095	0	.135	1	.234	1
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	0	.097	1	.136	1	.236	1
.021	0	.055	0	.098	1	.137	1	.237	1
.022	1	.055	0	.098	1	.137	1	.237	1
.025	0	.055	0	.099	0	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	0	.138	1	.240	1
.025	0	.057	0	.100	1	.140	1	.241	1
.026	0	.057	0	.102	1	.140	1	.242	1
.028	0	.058	0	.103	1	.140	1	.242	1
.028	0	.060	1	.105	0	.141	1	.243	1
.030	0	.060	0	.105	0	.141	1	.245	1
.030	0	.060	0	.105	1	.145	0	.245	1
.031	0	.063	1	.105	1	.145	1	.245	0
.032	0	.063	1	.106	1	.146	0	.246	1
.035	0	.063	1	.107	0	.147	1	.246	1
.035	0	.064	0	.107	1	.147	0	.246	1
.035	0	.065	0	.111	0	.149	1	.248	1
.035	0	.067	0	.111	0	.150	1	.248	1
.035	0	.070	1	.111	0	.151	1	.248	1
.036	0	.070	1	.112	1	.151	1	.250	1
.036	0	.071	0	.115	1	.152	1	.250	1
.038	0	.071	1	.115	1	.152	1	.250	1
.038	0	.073	0	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	0	.076	1	.120	0	.170	1	.260	1
.039	1	.076	0	.120	1	.180	1	.262	1
.040	1	.077	0	.121	0	.180	1	.262	1
.040	0	.077	0	.122	1	.185	1	.265	1
.040	0	.078	0	.122	1	.185	1	.265	1
.040	0	.078	0	.122	0	.190	0	.268	1
.040	0	.080	1	.123	0	.190	1	.268	1
.040	0	.080	0	.123	1	.192	1	.270	1
.041	0	.080	1	.123	0	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	0	.126	0	.212	1	.300	1
.043	1	.081	0	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	0	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	1	.085	0	.130	1	.223	1	.347	1
.045	0	.085	1	.130	1	.225	1	.350	1
.045	0	.086	1	.130	1	.226	1		

INSPECTION # 20 NUMBER OF POINTS :281

.007	0	.044	0	.094	1	.142	1	.236	1
.007	0	.045	0	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	1
.011	0	.047	0	.095	1	.145	1	.240	1
.012	0	.047	1	.096	0	.145	1	.240	1
.012	0	.048	0	.097	1	.147	1	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	0	.100	1	.148	1	.243	1
.014	0	.052	1	.100	0	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	1	.102	1	.150	1	.248	1
.016	0	.057	0	.103	1	.152	1	.249	1
.017	1	.057	1	.104	1	.152	1	.250	1
.017	0	.059	0	.105	1	.152	1	.250	1
.018	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	1	.066	1	.115	1	.165	1	.257	1
.022	0	.066	0	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	1	.260	1
.023	0	.070	1	.118	0	.175	1	.260	1
.025	0	.070	0	.118	1	.177	1	.261	1
.026	0	.070	1	.119	1	.179	1	.262	1
.026	0	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	1	.125	1	.191	1	.265	1
.033	0	.073	0	.125	0	.192	1	.270	1
.034	0	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	0	.272	1
.035	0	.080	0	.128	1	.197	1	.272	1
.035	0	.080	1	.130	1	.200	1	.273	1
.036	0	.080	1	.130	1	.200	1	.275	1
.037	0	.081	1	.132	1	.201	0	.275	1
.038	1	.082	0	.132	1	.203	1	.278	1
.039	1	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	1
.040	0	.087	1	.135	1	.208	1	.300	1
.041	0	.087	1	.136	0	.212	1	.302	1
.042	1	.087	0	.138	1	.213	1	.315	1
.042	1	.089	1	.139	1	.215	1	.365	1
.042	0	.090	1	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION # 21

NUMBER OF POINTS :281

.007	0
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INSPECTION # 22

NUMBER OF POINTS :284

.008	0	.045	1	.087	1	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	1	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	1	.233	1
.018	0	.050	1	.095	1	.135	0	.233	1
.018	1	.052	1	.095	0	.135	1	.234	1
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	1	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	1	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	1	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	0	.060	1	.105	1	.141	1	.243	1
.030	1	.060	0	.105	1	.141	1	.245	1
.030	1	.060	0	.105	1	.145	1	.245	1
.031	1	.063	0	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	1	.107	1	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	1	.070	0	.112	1	.151	1	.250	0
.036	1	.071	1	.115	1	.152	1	.250	1
.038	0	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	0	.075	1	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	1	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	0	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	0	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION #23

NUMBER OF POINTS :281

.007	0
.007	0
.010	0
.011	0
.012	0
.012	0
.012	0
.013	0
.013	0
.014	0
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.015	0
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.016	0
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.018	1
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.025	0
.026	1
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.035	0
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.036	1
.037	0
.038	0
.039	0
.040	1
.040	1
.041	0
.042	0
.042	1
.042	1
.042	1
.043	0
.043	1
.043	1
.044	1
.045	0
.046	1
.047	1
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.048	1
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.086	1
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.272	1
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.273	1
.275	1
.275	0
.278	1
.280	1
.298	1
.300	1
.302	1
.315	1
.365	1
.422	1

INSPECTION # 24 NUMBER OF POINTS :284

.008	0	.045	1	.087	1	.130	1	.227	1
.010	0	.046	1	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	1	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	1	.135	1	.234	0
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	0	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	1	.055	1	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	0	.099	1	.137	1	.240	1
.025	1	.055	1	.100	1	.138	1	.240	1
.025	1	.056	0	.100	1	.138	1	.240	1
.025	1	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	0	.140	1	.242	1
.028	0	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	0	.060	0	.105	1	.141	1	.245	1
.030	0	.060	0	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	0	.107	1	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	1	.070	1	.112	1	.151	0	.250	1
.036	1	.071	0	.115	1	.152	1	.250	1
.038	1	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	0	.076	1	.120	1	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	1	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	1	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	0	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 25 NUMBER OF POINTS :281

.007	0	.044	1	.094	1	.142	1	.236	1
.007	0	.045	1	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	1
.011	0	.047	1	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	1	.240	1
.012	0	.048	1	.097	1	.147	1	.242	1
.012	0	.050	1	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	0	.100	1	.148	1	.243	1
.014	0	.052	1	.100	1	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	1	.103	1	.152	1	.249	1
.017	1	.057	1	.104	1	.152	1	.250	1
.017	0	.059	1	.105	1	.152	1	.250	1
.018	1	.060	1	.105	1	.153	1	.252	1
.019	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	1	.066	1	.115	1	.165	1	.257	1
.022	0	.066	1	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	1	.260	1
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	1	.119	1	.179	1	.262	1
.026	0	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	1	.125	1	.191	1	.265	1
.033	0	.073	1	.125	1	.192	1	.270	1
.034	0	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	1	.272	1
.035	1	.080	1	.128	1	.197	1	.272	1
.035	0	.080	1	.130	1	.200	1	.273	1
.036	1	.080	1	.130	1	.200	1	.275	1
.037	1	.081	1	.132	1	.201	1	.275	1
.038	0	.082	1	.132	1	.203	1	.278	1
.039	1	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	1
.040	1	.087	1	.135	1	.208	1	.300	1
.041	1	.087	1	.136	1	.212	1	.302	1
.042	0	.087	1	.138	1	.213	1	.315	1
.042	1	.089	1	.139	1	.215	1	.365	1
.042	1	.090	1	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	1	.092	1	.140	1	.235	1		
.043	1	.093	1	.142	1	.236	1		

INSPECTION # 26 NUMBER OF POINTS :284

.008	0	.045	1	.087	1	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	0	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	1	.049	0	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	1	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	1	.135	1	.234	1
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	1	.098	1	.137	1	.237	1
.025	0	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	0	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	0	.060	1	.105	0	.141	1	.245	1
.030	0	.060	0	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	0	.064	1	.107	1	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	0	.070	1	.111	1	.151	1	.248	1
.036	1	.070	1	.112	1	.151	1	.250	1
.036	1	.071	0	.115	1	.152	1	.250	1
.038	0	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	1	.076	0	.120	1	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	0	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	0
.045	1	.085	1	.130	1	.223	1	.347	1
.045	0	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION #27

NUMBER OF POINTS :281

.007	0
.007	0
.010	0
.011	0
.012	0
.012	0
.012	0
.013	0
.013	0
.014	0
.014	0
.015	0
.015	0
.016	0
.016	0
.017	1
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.018	0
.019	0
.019	0
.020	0
.020	0
.020	0
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.021	0
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.365	1
.422	1

INSPECTION #28 NUMBER OF POINTS :281

.007	0	.044	0	.094	1	.142	1	.236	1
.007	0	.045	0	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	0
.011	0	.047	0	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	1	.240	1
.012	0	.048	1	.097	1	.147	1	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	0	.100	1	.148	1	.243	1
.014	0	.052	0	.100	1	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	0	.103	1	.152	1	.249	1
.017	1	.057	0	.104	1	.152	1	.250	1
.017	0	.059	1	.105	1	.152	1	.250	1
.018	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	0	.114	1	.163	1	.256	1
.021	0	.065	0	.115	1	.163	1	.256	1
.022	1	.066	1	.115	1	.165	1	.257	1
.022	0	.066	1	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	0	.173	1	.260	1
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	1	.119	1	.179	1	.262	1
.026	0	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	1	.125	1	.191	1	.265	1
.033	0	.073	0	.125	1	.192	1	.270	1
.034	0	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	1	.272	1
.035	0	.080	1	.128	1	.197	1	.272	1
.035	0	.080	1	.130	1	.200	1	.273	1
.036	1	.080	1	.130	1	.200	1	.275	1
.037	0	.081	1	.132	1	.201	0	.275	1
.038	0	.082	0	.132	1	.203	1	.278	1
.039	1	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	1
.040	0	.087	1	.135	1	.208	1	.300	1
.041	0	.087	1	.136	1	.212	1	.302	1
.042	0	.087	0	.138	1	.213	1	.315	1
.042	0	.089	1	.139	1	.215	1	.365	1
.042	0	.090	1	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	0	.092	1	.140	1	.222	1		
.043	0	.092	0	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION #29

NUMBER OF POINTS :281

.007	0
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INSPECTION #30

NUMBER OF POINTS :284

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INSPECTION #31

NUMBER OF POINTS :281

.007	0	.044	1	.094	1	.142	1	.236	1
.007	0	.045	1	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	1
.011	0	.047	1	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	1	.240	1
.012	0	.048	1	.097	1	.147	1	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	1	.100	1	.148	1	.243	1
.014	0	.052	1	.100	1	.148	1	.245	1
.014	1	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	1	.102	1	.150	1	.248	1
.016	0	.057	1	.103	1	.152	1	.249	1
.017	1	.057	1	.104	1	.152	1	.250	1
.017	0	.059	1	.105	1	.152	1	.250	1
.018	1	.060	1	.105	1	.153	1	.252	1
.019	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	1	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	1	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	1	.066	1	.115	1	.165	1	.257	1
.022	1	.066	1	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	1	.260	1
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	1	.119	1	.179	1	.262	1
.026	1	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	1	.073	1	.125	1	.191	1	.265	1
.033	0	.073	1	.125	1	.192	1	.270	1
.034	1	.077	1	.126	1	.192	1	.270	1
.035	1	.077	1	.127	1	.197	1	.272	1
.035	1	.080	1	.128	1	.197	1	.272	1
.035	1	.080	1	.130	1	.200	1	.273	1
.036	0	.080	1	.130	1	.200	1	.275	1
.037	1	.081	1	.132	1	.201	1	.275	1
.038	1	.082	0	.132	1	.203	1	.278	1
.039	0	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	1
.040	1	.087	1	.135	1	.208	1	.300	1
.041	1	.087	1	.136	1	.212	1	.302	1
.042	1	.087	0	.138	1	.213	1	.315	1
.042	1	.089	1	.139	1	.215	1	.365	1
.042	0	.090	1	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	1	.092	1	.140	1	.235	1		
.043	1	.093	1	.142	1	.236	1		

INSPECTION #32

NUMBER OF POINTS :281

.007	0	.044	1	.094	1	.142	1	.236	1
.007	0	.045	1	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	0
.011	0	.047	1	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	1	.240	1
.012	0	.048	1	.097	1	.147	1	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	1	.100	1	.148	1	.243	1
.014	0	.052	1	.100	1	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	1	.102	1	.150	1	.248	1
.016	0	.057	1	.103	1	.152	1	.249	1
.017	1	.057	1	.104	1	.152	1	.250	1
.017	0	.059	1	.105	1	.152	1	.250	1
.018	1	.060	1	.105	1	.153	1	.252	1
.019	0	.060	1	.105	0	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	1	.066	1	.115	1	.165	1	.257	1
.022	0	.066	1	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	1	.260	1
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	1	.119	1	.179	0	.262	1
.026	0	.072	0	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	1	.125	1	.191	1	.265	1
.033	0	.073	0	.125	1	.192	1	.270	1
.034	1	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	1	.272	1
.035	0	.080	1	.128	1	.197	1	.272	1
.035	1	.080	1	.130	1	.200	1	.273	1
.036	1	.080	1	.130	1	.200	1	.275	1
.037	0	.081	0	.132	1	.201	0	.275	1
.038	1	.082	0	.132	1	.203	1	.278	1
.039	1	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	1
.040	1	.087	1	.135	1	.208	1	.300	1
.041	0	.087	1	.136	1	.212	1	.302	1
.042	0	.087	0	.138	1	.213	1	.315	1
.042	1	.089	1	.139	1	.215	1	.365	1
.042	0	.090	1	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	1	.092	1	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION #33

NUMBER OF POINTS :284

.008	0	.045	1	.087	1	.130	1	.227	1
.010	0	.046	1	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	1	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	0	.135	1	.234	1
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	1	.054	1	.097	1	.136	1	.236	1
.021	1	.055	1	.098	1	.137	1	.237	1
.022	1	.055	1	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	1	.056	0	.100	1	.138	1	.240	1
.025	1	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	1	.141	1	.245	1
.030	1	.060	1	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	0	.147	1	.246	1
.035	1	.064	1	.107	1	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	1	.070	1	.112	1	.151	1	.250	1
.036	1	.071	1	.115	1	.152	1	.250	1
.038	1	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	0	.076	1	.120	1	.180	1	.262	1
.040	1	.077	1	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	0	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 34

NUMBER OF POINTS :284

.008	0	.045	1	.087	1	.130	1	.227	1
.010	0	.046	1	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	1	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	1	.135	1	.234	1
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	1	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	1	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	1	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	0	.141	1	.245	1
.030	1	.060	0	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	1	.107	0	.147	1	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	1	.067	0	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	1	.250	1
.036	0	.071	0	.115	1	.152	1	.250	1
.038	1	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	0	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	0	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION #35

NUMBER OF POINTS :281

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INSPECTION # 36

NUMBER OF POINTS :281

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INSPECTION #37

NUMBER OF POINTS :284

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.145	1
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.146	1
.147	1
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.149	1
.150	1
.151	1
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.152	1
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.165	1
.167	1
.170	1
.170	1
.180	1
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.185	1
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.200	1
.204	1
.211	1
.212	1
.214	1
.216	1
.220	1
.222	1
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.250	1
.252	1
.256	1
.260	1
.260	1
.262	1
.262	1
.265	1
.265	1
.268	1
.268	1
.270	1
.270	1
.283	1
.285	1
.300	1
.301	1
.310	1
.315	1
.330	1
.347	1
.350	1

INSPECTION #38 NUMBER OF POINTS : 72

.010	0
.012	0
.020	0
.025	1
.025	1
.028	1
.030	1
.035	1
.038	1
.038	1
.038	1
.039	1
.040	1
.042	1
.045	1
.050	1
.050	1
.052	1
.055	1
.055	0
.056	0
.057	1
.060	1
.063	1
.063	1
.063	1
.064	1
.067	1
.070	1
.073	1
.078	1
.085	0
.085	1
.086	1
.087	1
.095	1
.095	1
.097	1
.097	1
.098	1
.100	1
.103	1
.111	1
.117	0
.118	1
.120	0
.122	1
.126	1
.126	1
.127	1
.130	1
.135	0
.135	1
.136	1
.149	1
.151	1
.170	1
.180	1
.180	1
.223	1
.228	1
.229	1
.232	1
.234	1
.237	1
.245	1
.246	1
.270	1
.300	1
.301	1
.310	1
.350	1

INSPECTION #39 NUMBER OF POINTS : 90

.012	0	.148	1
.014	0	.150	1
.020	0	.152	1
.023	0	.152	1
.027	0	.152	1
.027	1	.156	1
.033	0	.163	1
.034	1	.163	1
.036	1	.175	1
.037	1	.179	1
.039	1	.180	1
.040	1	.191	1
.040	1	.197	1
.042	1	.208	1
.042	1	.212	1
.043	1	.215	1
.044	1	.215	1
.045	1	.235	1
.046	1	.236	1
.050	1	.240	1
.050	1	.242	1
.057	1	.242	1
.057	1	.245	1
.060	1	.247	1
.062	1	.252	1
.065	1	.255	1
.065	1	.256	1
.067	0	.257	1
.070	1	.260	1
.070	1	.262	1
.070	1	.263	1
.072	1	.272	1
.072	1	.302	1
.073	1		
.080	1		
.082	1		
.086	1		
.087	1		
.090	1		
.094	1		
.095	1		
.100	1		
.102	1		
.103	1		
.105	1		
.105	1		
.107	1		
.115	1		
.117	1		
.128	1		
.136	1		
.139	1		
.140	1		
.142	1		
.145	1		
.147	1		
.148	1		

INSPECTION #40 NUMBER OF POINTS : 68

.022	1
.025	0
.025	1
.030	1
.031	1
.032	1
.035	0
.035	1
.035	0
.036	0
.040	1
.040	1
.043	1
.045	1
.045	0
.049	1
.052	1
.053	1
.055	1
.055	1
.057	1
.058	1
.060	1
.065	1
.070	0
.071	0
.071	1
.075	1
.075	1
.076	1
.077	1
.080	1
.082	1
.094	1
.095	1
.097	1
.105	1
.105	1
.111	1
.111	1
.115	1
.116	1
.120	1
.123	1
.130	1
.133	1
.133	1
.134	1
.136	1
.137	1
.138	1
.138	1
.140	1
.146	1
.212	1
.225	1
.226	1
.227	1
.228	1
.231	1
.233	1
.234	1
.240	1
.243	1
.245	1
.245	1
.250	1
.270	1

INSPECTION #41

NUMBER OF POINTS : 75

.012	0
.014	0
.018	1
.020	0
.025	1
.026	1
.032	0
.035	0
.035	1
.035	1
.038	1
.041	1
.042	1
.042	1
.043	1
.043	1
.047	1
.047	1
.048	1
.051	1
.052	1
.057	1
.057	1
.057	1
.059	1
.060	1
.060	1
.062	1
.063	1
.066	1
.066	1
.073	1
.073	1
.077	1
.080	1
.080	1
.089	1
.092	1
.097	1
.098	1
.100	1
.113	1
.118	1
.122	1
.122	1
.125	1
.126	1
.130	1
.130	1
.132	1
.140	1
.144	1
.145	1
.147	1
.148	1
.153	1
.172	1
.177	1
.180	1
.183	1
.190	1
.197	1
.240	1
.247	1
.249	1
.252	1
.254	1
.255	1
.260	1
.261	1
.262	1
.262	1
.265	1
.270	1
.298	1

INSPECTION #42

NUMBER OF POINTS : 72

.010	0
.012	0
.020	1
.025	0
.025	1
.028	1
.030	1
.035	0
.038	1
.038	0
.038	1
.039	0
.040	1
.042	1
.045	1
.050	1
.050	1
.052	0
.055	1
.055	1
.056	0
.057	1
.060	1
.063	1
.063	1
.063	1
.064	1
.067	1
.070	1
.073	0
.078	1
.085	1
.085	1
.086	1
.087	1
.095	1
.095	0
.097	1
.097	1
.098	1
.100	1
.103	1
.111	1
.117	1
.118	1
.120	0
.122	1
.126	1
.126	1
.127	1
.130	1
.135	1
.135	0
.136	1
.149	1
.151	1
.170	1
.180	1
.180	1
.223	1
.228	1
.229	1
.232	1
.234	1
.237	1
.245	1
.246	1
.270	1
.300	1
.301	1
.310	1
.350	0

INSPECTION #43 NUMBER OF POINTS : 72

.010	0	.180	1
.012	0	.180	1
.020	0	.223	1
.025	1	.228	1
.025	1	.229	1
.028	1	.232	1
.030	1	.234	1
.035	1	.237	1
.038	1	.245	1
.038	1	.246	1
.038	1	.270	1
.039	1	.300	1
.040	1	.301	1
.042	1	.310	1
.045	1	.350	1
.050	1		
.050	1		
.052	1		
.055	1		
.055	0		
.056	0		
.057	1		
.060	1		
.063	1		
.063	1		
.063	1		
.064	1		
.067	1		
.070	1		
.073	1		
.078	1		
.085	1		
.085	1		
.086	1		
.087	1		
.095	1		
.095	1		
.097	1		
.097	1		
.098	1		
.100	1		
.103	1		
.111	1		
.117	1		
.118	1		
.120	0		
.122	1		
.126	1		
.126	1		
.127	1		
.130	1		
.135	1		
.135	1		
.136	1		
.149	1		
.151	1		
.170	1		

INSPECTION #44 NUMBER OF POINTS : 68

.022	0
.025	0
.025	1
.030	0
.031	1
.032	1
.035	0
.035	1
.035	1
.036	1
.040	1
.040	1
.043	1
.045	1
.045	0
.049	1
.052	1
.053	1
.055	1
.055	1
.057	1
.058	1
.060	1
.065	0
.070	1
.071	1
.071	1
.075	1
.075	1
.076	1
.077	0
.080	1
.082	1
.094	1
.095	1
.097	1
.105	0
.105	1
.111	1
.111	1
.115	1
.116	1
.120	1
.123	1
.130	1
.133	1
.133	1
.134	1
.136	1
.137	1
.138	1
.138	1
.140	1
.146	1
.212	1
.225	1
.226	1
.227	1
.228	1
.231	1
.233	1
.234	1
.240	1
.243	1
.245	1
.245	1
.250	1
.270	1

INSPECTION #45

NUMBER OF POINTS : 68

.022	0
.025	1
.025	1
.030	1
.031	0
.032	1
.035	0
.035	1
.035	1
.036	0
.040	1
.040	1
.043	1
.045	1
.045	1
.049	1
.052	1
.053	1
.055	1
.055	1
.057	1
.058	1
.060	1
.065	1
.070	1
.071	1
.071	1
.075	1
.075	0
.076	1
.077	0
.080	1
.082	1
.094	1
.095	1
.097	1
.105	1
.105	1
.111	1
.111	1
.115	1
.116	1
.120	1
.123	1
.130	1
.133	1
.133	1
.134	1
.136	1
.137	1
.138	1
.138	1
.140	1
.146	1
.212	1
.225	1
.226	1
.227	1
.228	1
.231	1
.233	1
.234	1
.240	1
.243	1
.245	1
.245	1
.250	1
.270	1

INSPECTION #46 NUMBER OF POINTS :281

.007	0	.044	1	.094	1	.142	1	.236	1
.007	0	.045	1	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	0
.011	0	.047	1	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	0	.240	1
.012	0	.048	1	.097	1	.147	1	.242	1
.012	0	.050	1	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	1	.100	1	.148	1	.243	1
.014	0	.052	1	.100	1	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	1	.103	1	.152	1	.249	1
.017	0	.057	1	.104	1	.152	1	.250	1
.017	0	.059	1	.105	1	.152	1	.250	1
.018	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	0	.066	1	.115	1	.165	1	.257	1
.022	0	.066	1	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	1	.260	1
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	1	.119	1	.179	1	.262	1
.026	0	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	1	.125	1	.191	1	.265	1
.033	0	.073	0	.125	1	.192	1	.270	1
.034	1	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	1	.272	1
.035	0	.080	1	.128	1	.197	1	.272	1
.035	1	.080	1	.130	1	.200	1	.273	1
.036	1	.080	1	.130	1	.200	1	.275	1
.037	1	.081	1	.132	1	.201	0	.275	1
.038	1	.082	1	.132	1	.203	1	.278	1
.039	0	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	1
.040	1	.087	1	.135	1	.208	1	.300	1
.041	0	.087	1	.136	1	.212	1	.302	1
.042	0	.087	0	.138	1	.213	1	.315	1
.042	1	.089	1	.139	1	.215	1	.365	1
.042	0	.090	1	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	1	.092	1	.140	1	.235	1		
.043	1	.093	1	.142	1	.236	1		

INSPECTION #47 NUMBER OF POINTS :281

.007	0	.044	0	.094	0	.142	1	.236	1
.007	0	.045	0	.094	1	.144	0	.238	1
.010	0	.046	1	.095	1	.144	0	.238	1
.011	0	.047	0	.095	1	.145	1	.240	1
.012	0	.047	0	.096	1	.145	1	.240	1
.012	0	.048	0	.097	1	.147	1	.242	1
.012	0	.050	0	.098	0	.147	1	.242	1
.013	0	.050	0	.098	0	.147	1	.242	1
.013	0	.051	0	.100	1	.148	1	.243	1
.014	0	.052	0	.100	1	.148	0	.245	1
.014	0	.054	0	.100	0	.148	1	.245	1
.015	0	.057	0	.102	1	.148	1	.247	0
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	0	.103	1	.152	1	.249	1
.017	1	.057	0	.104	1	.152	1	.250	1
.017	0	.059	0	.105	0	.152	1	.250	0
.018	0	.060	0	.105	1	.153	0	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	0	.106	1	.153	1	.254	1
.020	0	.062	1	.107	0	.154	1	.255	1
.020	0	.062	0	.107	0	.155	1	.255	1
.020	0	.063	0	.110	0	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	0	.115	0	.163	1	.256	1
.022	0	.066	1	.115	0	.165	1	.257	1
.022	0	.066	0	.117	0	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	0	.173	1	.260	1
.023	0	.070	1	.118	0	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	0	.070	0	.119	1	.179	1	.262	1
.026	1	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	0	.262	1
.027	0	.072	0	.122	1	.183	0	.263	1
.027	0	.073	1	.123	0	.190	1	.265	1
.032	0	.073	0	.125	1	.191	1	.265	0
.033	0	.073	0	.125	0	.192	0	.270	1
.034	0	.077	1	.126	0	.192	1	.270	1
.035	0	.077	1	.127	1	.197	0	.272	1
.035	0	.080	0	.128	1	.197	1	.272	1
.035	0	.080	1	.130	1	.200	0	.273	1
.036	0	.080	0	.130	1	.200	1	.275	1
.037	1	.081	0	.132	1	.201	0	.275	1
.038	0	.082	1	.132	0	.203	1	.278	1
.039	0	.084	0	.132	1	.205	0	.280	1
.040	0	.086	1	.135	1	.206	0	.298	1
.040	0	.087	1	.135	1	.208	1	.300	0
.041	0	.087	0	.136	1	.212	1	.302	1
.042	0	.087	0	.138	1	.213	0	.315	1
.042	0	.089	0	.139	0	.215	0	.365	0
.042	0	.090	1	.139	0	.215	1	.422	1
.042	0	.091	1	.140	1	.215	1		
.043	0	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION #48 NUMBER OF POINTS :281

.007	0	.044	0	.094	1	.142	1	.236	1
.007	0	.045	0	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	0
.011	0	.047	0	.095	1	.145	1	.240	1
.012	0	.047	0	.096	0	.145	0	.240	1
.012	0	.048	0	.097	1	.147	1	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	1	.100	1	.148	1	.243	1
.014	0	.052	1	.100	0	.148	1	.245	1
.014	0	.054	0	.100	1	.148	1	.245	1
.015	0	.057	0	.102	1	.148	1	.247	1
.015	0	.057	1	.102	0	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	0	.103	1	.152	1	.249	1
.017	1	.057	0	.104	1	.152	1	.250	1
.017	0	.059	0	.105	1	.152	1	.250	1
.018	0	.060	1	.105	0	.153	0	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	0	.106	1	.153	1	.254	1
.020	0	.062	0	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	0	.115	1	.163	1	.256	1
.022	0	.066	1	.115	1	.165	1	.257	1
.022	0	.066	0	.117	1	.172	1	.257	1
.022	0	.067	1	.118	1	.173	1	.257	1
.023	0	.068	0	.118	1	.173	1	.260	1
.023	0	.070	0	.118	1	.175	1	.260	1
.025	0	.070	0	.118	1	.177	1	.261	1
.026	0	.070	1	.119	1	.179	1	.262	1
.026	0	.072	1	.121	0	.180	1	.262	1
.026	0	.072	0	.122	1	.180	1	.262	1
.027	0	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	1	.073	0	.125	1	.191	1	.265	1
.033	0	.073	0	.125	0	.192	1	.270	1
.034	0	.077	1	.126	1	.192	1	.270	1
.035	0	.077	0	.127	1	.197	1	.272	1
.035	0	.080	1	.128	1	.197	1	.272	1
.035	1	.080	0	.130	1	.200	1	.273	1
.036	0	.080	0	.130	1	.200	1	.275	1
.037	0	.081	1	.132	1	.201	0	.275	1
.038	1	.082	0	.132	1	.203	1	.278	1
.039	0	.084	1	.132	0	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	0
.040	0	.087	0	.135	1	.208	1	.300	1
.041	0	.087	1	.136	1	.212	1	.302	1
.042	0	.087	0	.138	1	.213	1	.315	1
.042	0	.089	1	.139	0	.215	1	.365	1
.042	0	.090	0	.139	1	.215	1	.422	1
.042	0	.091	1	.140	1	.215	1		
.043	0	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION #49 NUMBER OF POINTS :281

.007	0	.044	1	.094	1	.142	1	.236	1
.007	0	.045	1	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	1
.011	0	.047	1	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	1	.240	1
.012	0	.048	1	.097	1	.147	1	.242	1
.012	0	.050	1	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	1	.100	1	.148	1	.243	1
.014	0	.052	1	.100	1	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	1	.102	1	.150	0	.248	1
.016	0	.057	1	.103	1	.152	1	.249	1
.017	1	.057	1	.104	1	.152	1	.250	1
.017	0	.059	1	.105	1	.152	0	.250	1
.018	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	0	.066	1	.115	1	.165	1	.257	1
.022	0	.066	1	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	1	.260	1
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	1	.119	1	.179	1	.262	1
.026	0	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	1	.073	1	.125	1	.191	1	.265	1
.033	0	.073	0	.125	1	.192	1	.270	0
.034	0	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	1	.272	1
.035	0	.080	1	.128	1	.197	1	.272	1
.035	1	.080	1	.130	1	.200	1	.273	1
.036	0	.080	1	.130	1	.200	1	.275	1
.037	1	.081	1	.132	1	.201	0	.275	1
.038	1	.082	1	.132	1	.203	1	.278	1
.039	1	.084	0	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.298	1
.040	1	.087	0	.135	1	.208	1	.300	1
.041	1	.087	1	.136	1	.212	1	.302	1
.042	0	.087	0	.138	0	.213	1	.315	1
.042	0	.089	1	.139	1	.215	1	.365	1
.042	0	.090	0	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	1	.235	1		
.043	1	.093	1	.142	1	.236	1		

INSPECTION #50

NUMBER OF POINTS :284

.008	0
.010	0
.010	0
.010	0
.011	0
.012	0
.012	0
.015	0
.016	0
.018	0
.018	1
.019	0
.020	0
.020	0
.021	0
.022	0
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.350	1

INSPECTION # 51 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	0	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	0	.228	1
.011	0	.048	1	.091	1	.133	1	.229	0
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	0	.095	1	.135	1	.231	1
.015	0	.049	1	.095	1	.135	1	.232	0
.016	0	.050	1	.095	1	.135	0	.233	1
.018	0	.050	1	.095	1	.135	0	.233	1
.018	0	.052	1	.095	0	.135	1	.234	0
.019	0	.052	1	.097	1	.135	1	.234	0
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	1	.099	1	.137	1	.240	1
.025	1	.055	0	.100	1	.138	0	.240	0
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	0	.100	0	.140	1	.241	0
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	0	.141	1	.243	1
.030	0	.060	1	.105	0	.141	1	.245	1
.030	0	.060	1	.105	1	.145	1	.245	1
.031	0	.063	1	.105	0	.145	1	.245	1
.032	0	.063	0	.106	0	.146	1	.246	1
.035	0	.063	1	.107	0	.147	1	.246	1
.035	1	.064	1	.107	1	.147	0	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	0	.070	0	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	0	.250	1
.036	0	.071	0	.115	1	.152	1	.250	0
.038	0	.071	1	.115	1	.152	1	.250	1
.038	1	.073	0	.116	1	.165	1	.252	0
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	1	.076	0	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	0	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	0	.190	1	.268	1
.040	0	.080	1	.123	1	.190	1	.268	1
.040	0	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	0
.042	1	.080	1	.125	1	.204	1	.283	0
.042	1	.080	0	.126	1	.211	1	.285	1
.042	0	.080	0	.126	1	.212	1	.300	1
.043	1	.081	0	.127	0	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	0	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	0	.085	0	.130	0	.223	1	.347	1
.045	1	.085	0	.130	0	.225	0	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 52

NUMBER OF POINTS :281

.007	0
.007	0
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.012	0
.012	0
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.365	1
.422	1

INSPECTION # 53

NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	0	.095	1	.135	1	.232	1
.016	0	.050	1	.095	0	.135	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	1	.135	1	.234	0
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	0	.098	1	.137	0	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	0	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	1	.056	0	.100	1	.138	1	.240	1
.025	0	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	0	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	0	.141	1	.245	1
.030	1	.060	1	.105	1	.145	1	.245	1
.031	0	.063	0	.105	0	.145	1	.245	1
.032	0	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	1	.107	0	.147	1	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	1	.067	1	.111	0	.150	1	.248	0
.035	1	.070	1	.111	1	.151	1	.248	1
.036	1	.070	1	.112	1	.151	0	.250	1
.036	0	.071	0	.115	1	.152	1	.250	1
.038	1	.071	1	.115	1	.152	1	.250	1
.038	0	.073	0	.116	1	.165	1	252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	0	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
040	0	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	0	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	1
.045	0	.085	0	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	0
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 54 NUMBER OF POINTS :281

.007	0	.044	1	.094	1	.142	1	.236	1
.007	0	.045	0	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	1	.238	0
.011	0	.047	1	.095	1	.145	1	.240	1
.012	0	.047	1	.096	1	.145	1	.240	1
.012	0	.048	1	.097	1	.147	1	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	1	.147	1	.242	1
.013	0	.051	1	.100	1	.148	1	.243	1
.014	0	.052	1	.100	0	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	1	.103	1	.152	1	.249	1
.017	0	.057	1	.104	1	.152	1	.250	1
.017	0	.059	1	.105	1	.152	1	.250	1
.018	1	.060	1	.105	1	.153	1	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	1	.062	1	.107	1	.154	1	.255	1
.020	0	.062	1	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	1	.115	1	.163	1	.256	1
.022	1	.066	1	.115	1	.165	1	.257	1
.022	1	.066	1	.117	1	.172	1	.257	1
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	1	.173	1	.260	1
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	1	.119	1	.179	1	.262	1
.026	1	.072	1	.121	0	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	1	.125	1	.191	1	.265	1
.033	0	.073	0	.125	1	.192	1	.270	1
.034	0	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	1	.272	1
.035	0	.080	1	.128	1	.197	1	.272	1
.035	1	.080	1	.130	1	.200	1	.273	1
.036	1	.080	1	.130	1	.200	1	.275	1
.037	1	.081	1	.132	1	.201	1	.275	1
.038	1	.082	0	.132	0	.203	1	.278	1
.039	1	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	1	.288	1
.040	0	.087	1	.135	1	.208	1	.300	1
.041	0	.087	1	.136	1	.212	1	.302	1
.042	1	.087	0	.138	1	.213	1	.315	1
.042	1	.089	1	.139	1	.215	1	.365	1
.042	0	.090	1	.139	1	.215	1	.422	1
.042	1	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	1	.235	1		
.043	1	.093	1	.142	1	.236	1		

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INSPECTION #55 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	0	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	0	.091	1	.133	0	.228	1
.011	0	.048	0	.091	1	.133	1	.229	1
.012	0	.048	0	.094	1	.134	-1	.230	1
.012	0	.049	0	.095	1	.135	0	.231	-1
.015	0	.049	0	.095	1	.135	0	.232	1
.016	0	.050	0	.095	0	.135	0	.233	1
.018	0	.050	0	.095	1	.135	0	.233	1
.018	0	.052	1	.095	0	.135	1	.234	0
.019	0	.052	0	.097	-1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	1	.099	0	.137	-1	.240	1
.025	0	.055	0	.100	1	.138	-1	.240	1
.025	0	.056	0	.100	1	.138	0	.240	1
.025	0	.057	1	.100	0	.140	1	.241	1
.026	0	.057	0	.102	0	.140	1	.242	1
.028	0	.058	-1	.103	0	.140	1	.242	0
.028	0	.060	0	.105	0	.141	1	.243	-1
.030	-1	.060	1	.105	-1	.141	1	.245	1
.030	0	.060	1	.105	1	.145	1	.245	1
.031	-1	.063	1	.105	0	.145	1	.245	1
.032	-1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	0	.107	0	.147	0	.246	0
.035	0	.064	1	.107	0	.147	0	.246	1
.035	0	.065	0	.111	0	.149	0	.248	1
.035	0	.067	0	.111	1	.150	1	.248	1
.035	-1	.070	0	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	0	.250	1
.036	0	.071	-1	.115	1	.152	1	.250	0
.038	0	.071	1	.115	1	.152	1	.250	1
.038	0	.073	0	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	0	.076	0	.120	1	.180	1	.262	0
.040	0	.077	-1	.121	1	.180	1	.262	1
.040	-1	.077	0	.122	1	.185	1	.265	1
.040	0	.078	1	.122	0	.185	1	.265	0
.040	0	.078	1	.122	0	.190	1	.268	0
.040	0	.080	1	.123	0	.190	1	.268	0
.040	0	.080	1	.123	1	.192	1	.270	1
.041	0	.080	0	.123	0	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	0	.080	0	.126	1	.211	1	.285	1
.042	0	.080	0	.126	1	.212	-1	.300	1
.043	1	.081	0	.127	1	.214	1	.301	0
.043	1	.081	1	.130	1	.216	1	.310	1
.043	0	.082	-1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	0	.330	1
.045	0	.085	0	.130	0	.223	1	.347	1
.045	1	.085	0	.130	0	.225	-1	.350	0
.045	1	.086	1	.130	1	.226	1		

INSPECTION #56 NUMBER OF POINTS : 75

.012	0
.013	0
.014	0
.018	0
.020	1
.020	1
.025	1
.026	1
.026	1
.026	0
.035	-1
.035	1
.035	1
.038	1
.042	0
.042	1
.043	1
.047	1
.047	1
.048	1
.051	1
.052	1
.057	1
.057	-1
.057	1
.060	1
.060	1
.062	1
.063	1
.065	0
.066	1
.066	1
.073	0
.077	1
.080	1
.080	1
.087	1
.089	1
.092	1
.098	1
.100	1
.106	1
.113	-1
.118	1
.122	1
.122	1
.125	1
.126	1
.130	1
.130	1
.140	1
.144	1
.147	1
.148	-1
.153	1
.153	1
.172	1
.177	1
.180	1
.183	1
.190	1
.197	1
.201	1
.240	1
.248	1
.249	-1
.254	1
.255	1
.255	1
.260	1
.261	1
.262	1
.262	1
.265	1
.270	1

INSPECTION #57 NUMBER OF POINTS : 68

.020	0
.022	0
.025	1
.030	1
.031	1
.032	1
.035	1
.035	0
.035	1
.036	0
.040	1
.040	1
.045	0
.045	1
.045	0
.049	0
.052	1
.053	1
.055	1
.055	1
.056	0
.058	0
.060	1
.063	1
.065	1
.070	1
.071	0
.071	1
.075	1
.076	1
.077	1
.080	1
.082	1
.094	1
.095	0
.097	1
.105	0
.105	1
.111	1
.115	1
.116	1
.120	1
.123	1
.127	1
.130	1
.133	1
.133	1
.134	1
.136	1
.137	1
.138	0
.138	1
.140	1
.212	1
.225	1
.226	1
.227	1
.228	1
.231	1
.233	1
.234	0
.234	1
.240	1
.243	1
.245	1
.245	1
.250	1
.270	1

INSPECTION #58 NUMBER OF POINTS : 72

.010	0
.012	0
.025	1
.025	0
.025	1
.028	1
.030	1
.035	1
.038	1
.038	0
.038	0
.039	0
.040	1
.042	1
.043	1
.050	1
.050	1
.052	1
.055	0
.055	1
.057	1
.057	1
.060	1
.063	1
.063	1
.064	1
.067	-1
.070	1
.073	1
.075	0
.078	1
.080	1
.085	-1
.085	1
.086	1
.087	0
.095	1
.095	0
.097	1
.097	1
.098	1
.100	1
.103	1
.111	1
.111	1
.117	0
.118	-1
.122	1
.126	0
.126	1
.130	1
.135	1
.135	1
.136	1
.146	1
.149	1
.151	1
.170	1
.180	1
.180	1
.223	1
.228	1
.229	1
.232	1
.237	1
.245	1
.246	1
.270	1
.300	1
.301	1
.310	1
.350	1

INSPECTION # 59 NUMBER OF POINTS :284

.008	0	.045	0	.087	1	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	0	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	[illegible]	1	.230	1
.012	0	.049	1	.095	1	[illegible]	1	.231	1
.015	0	.049	1	.095	0	[illegible]	1	.232	1
.016	0	.050	1	.095	1	[illegible]	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	0	.052	1	.095	1	.135	1	.234	0
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	0	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	1	.055	0	.098	1	.137	1	[illegible]	1
.025	0	.055	1	.099	1	.137	1	[illegible]	1
.025	0	.055	1	.100	0	.138	1	.240	1
.025	1	.056	0	.100	1	.138	1	.240	1
.025	0	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	0	.105	1	.141	1	.243	1
.030	1	.060	1	.105	1	.141	1	.245	1
.030	1	.060	1	.105	1	.145	1	.245	1
.031	0	.063	1	.105	1	.145	1	.245	1
.032	0	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	0	.147	1	.246	1
.035	1	.064	1	.107	0	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	0	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	1	.070	1	.112	1	.151	0	.250	1
.036	1	.071	0	.115	1	.152	1	.250	0
.038	1	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	1	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	0
.040	0	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	0	.283	1
.042	0	.080	0	.126	1	.211	1	.285	1
.042	0	.080	0	.126	1	.212	1	.300	1
.043	1	.081	0	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	1
.045	0	.085	0	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 60 NUMBER OF POINTS :284

.008	0	.045	1	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	0	.090	1	.133	1	.228	1
.010	0	.047	0	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	0	.134	1	.230	1
.012	0	.049	1	.095	1	.135	0	.231	1
.015	1	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	0	.135	1	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	0	.052	1	.095	1	.135	1	.234	0
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	0	.097	1	.136	1	.236	1
.021	0	.055	0	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	0	.240	1
.025	0	.057	1	.100	0	.140	1	.241	1
.026	0	.057	1	.102	1	.140	0	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	0	.060	1	.105	1	.141	1	.245	1
.030	0	.060	1	.105	1	.145	1	.245	1
.031	0	.063	0	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	0	.107	0	.147	1	.246	1
.035	0	.064	1	.107	0	.147	1	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	0	.067	1	.111	1	.150	1	.248	1
.035	0	.070	1	.111	1	.151	1	.248	0
.036	0	.070	1	.112	0	.151	0	.250	1
.036	0	.071	1	.115	1	.152	1	.250	1
.038	1	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	0	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	1	.076	1	.120	0	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	1	.121	1	.180	1	.262	1
.040	0	.077	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	0
.040	0	.078	1	.122	1	.190	1	.268	1
.040	0	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	0	.080	1	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	0	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	0	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	1
.045	1	.085	0	.130	1	.223	1	.347	1
.045	1	.085	1	.130	0	.225	1	.350	1
.045	0	.086	1	.130	1	.226	1		

INSPECTION # 61 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	0	.091	1	.133	1	.228	1
.011	0	.048	1	.091	0	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	1	.095	1	.135	1	.232	0
.016	0	.050	1	.095	1	.135	1	.233	1
.018	0	.050	0	.095	1	.135	1	.233	1
.018	0	.052	1	.095	1	.135	1	.234	0
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	1	.055	0	.098	1	.137	1	.237	1
.025	0	.055	0	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	1	.100	1	.140	1	.241	1
.026	0	.057	0	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	0	.105	1	.141	1	.245	1
.030	0	.060	1	.105	1	.145	1	.245	1
.031	1	.063	0	.105	0	.145	1	.245	1
.032	0	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	1	.107	1	.147	1	.246	1
.035	1	.065	1	.111	1	.149	1	.248	1
.035	0	.067	1	.111	1	.150	1	.248	1
.035	0	.070	0	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	1	.250	1
.036	0	.071	1	.115	1	.152	1	.250	0
.038	0	.071	1	.115	1	.152	1	.250	1
.038	1	.073	0	.116	1	.165	1	.252	1
.038	0	.075	1	.117	0	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	0	.076	1	.120	0	.170	1	.260	0
.039	0	.076	1	.120	1	.180	1	.262	1
.040	1	.077	1	.121	1	.180	1	.262	1
.040	1	.077	0	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.190	1	.268	1
.040	0	.080	1	.123	1	.190	1	.268	1
.040	0	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	1	.080	0	.126	1	.211	1	.285	1
.042	0	.080	0	.126	1	.212	1	.300	1
.043	0	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	0
.045	0	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION #62 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	0	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	0	.135	1	.234	0
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	1	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	0
.025	0	.056	0	.100	1	.138	1	.240	1
.025	1	.057	1	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	0	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	0	.141	1	.245	1
.030	1	.060	1	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	0	.147	1	.246	1
.035	1	.064	1	.107	0	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	0	.250	1
.036	1	.071	0	.115	1	.152	1	.250	0
.038	1	.071	1	.115	0	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	0	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	1	.085	1	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION # 63 NUMBER OF POINTS :284

.008	0
.010	0
.010	0
.010	0
.011	0
.012	0
.012	0
.015	0
.016	0
.018	0
.018	1
.019	0
.020	0
.020	0
.021	0
.022	1
.025	1
.025	0
.025	1
.025	0
.026	0
.028	1
.028	1
.030	1
.030	0
.031	1
.032	1
.035	0
.035	1
.035	0
.035	1
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.036	1
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.038	0
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.039	1
.040	1
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.040	1
.040	1
.040	1
.040	1
.041	1
.042	0
.042	1
.042	0
.043	1
.043	1
.043	0
.045	0
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.045	1
.045	0
.046	0
.046	1
.047	1
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.081	0
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.082	1
.085	1
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.086	1
.087	1
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.265	1
.265	1
.268	1
.268	1
.270	1
.270	1
.283	1
.285	1
.300	1
.301	1
.310	1
.315	1
.330	1
.347	1
.350	1

INSPECTION # 64

NUMBER OF POINTS :284

.008	0	.045	1	.087	1	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	1	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	0	.135	1	.234	0
.019	0	.052	1	.097	0	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	1	.057	0	.100	1	.140	1	.241	1
.026	1	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	1	.141	1	.245	1
.030	1	.060	0	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	0	.246	0
.035	0	.063	1	.107	1	.147	0	.246	1
.035	1	.064	1	.107	0	.147	1	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	0	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	0	.151	1	.248	1
.036	1	.070	1	.112	1	.151	1	.250	1
.036	1	.071	1	.115	1	.152	1	.250	1
.038	0	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	118	1	.170	1	.260	1
.038	1	.076	1	.120	0	.170	1	.260	1
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	0	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.130	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	1	.085	0	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	0	.130	1	.226	1		

INSPECTION #65 **NUMBER OF POINTS :284**

.008	0	.045	1	.087	1	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	0
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	1	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	1	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	1	.135	1	.234	1
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	1	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	1	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	1	.055	1	.100	1	.138	1	.240	1
.025	1	.056	0	.100	1	.138	1	.240	1
.025	1	.057	1	.100	1	.140	1	.241	1
.026	1	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	0	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	1	.060	1	.105	1	.141	1	.245	1
.030	0	.060	1	.105	1	.145	1	.245	1
.031	1	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	1	.064	1	.107	1	.147	1	.246	1
.035	1	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	1	.070	1	.112	1	.151	1	.250	1
.036	1	.071	1	.115	1	.152	1	.250	0
.038	1	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	1	.076	1	.120	0	.170	1	.260	0
.039	1	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	1	.085	1	.130	1	.222	1	.330	1
.045	1	.085	1	.130	1	.223	1	.347	1
.045	1	.085	1	.130	1	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION #66

NUMBER OF POINTS :281

.007	0
.007	0
.010	0
.011	0
.012	0
.012	0
.012	0
.013	0
.013	0
.014	0
.014	0
.015	0
.015	0
.016	0
.016	0
.017	0
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.018	1
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.020	0
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INSPECTION #67 NUMBER OF POINTS :281

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.011	0	.047	0	.095	1	.145	1	.240	1
.012	0	.047	0	.096	1	.145	1	.240	1
.012	0	.048	0	.097	1	.147	0	.242	1
.012	0	.050	0	.098	1	.147	1	.242	1
.013	0	.050	1	.098	0	.147	1	.242	1
.013	0	.051	0	.100	1	.148	1	.243	1
.014	0	.052	0	.100	1	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	1
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	0	.103	1	.152	1	.249	1
.017	0	.057	1	.104	1	.152	1	.250	1
.017	0	.059	0	.105	1	.152	1	.250	1
.018	0	.060	1	.105	1	.153	1	.252	1
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	1	.106	1	.153	1	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	0	.107	1	.155	1	.255	1
.020	0	.063	0	.110	1	.155	1	.255	1
.020	0	.065	0	.113	0	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	1
.021	0	.065	0	.115	0	.163	1	.256	1
.022	0	.066	1	.115	1	.165	1	.257	1
.022	0	.066	1	.117	1	.172	1	.257	0
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	0	.173	1	.260	0
.023	0	.070	1	.118	1	.175	1	.260	1
.025	0	.070	1	.118	1	.177	1	.261	1
.026	1	.070	0	.119	1	.179	1	.262	1
.026	1	.072	1	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	1	.262	1
.027	0	.072	1	.122	0	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	0	.125	1	.191	1	.265	1
.033	0	.073	0	.125	1	.192	1	.270	1
.034	1	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	1	.272	1
.035	0	.080	1	.128	1	.197	1	.272	1
.035	0	.080	1	.130	0	.200	1	.273	1
.036	1	.080	0	.130	1	.200	1	.275	1
.037	0	.081	0	.132	1	.201	1	.275	0
.038	0	.082	1	.132	1	.203	1	.278	1
.039	0	.084	1	.132	1	.205	1	.280	1
.040	1	.086	1	.135	1	.206	0	.298	1
.040	0	.087	1	.135	1	.208	1	.300	1
.041	0	.087	1	.136	0	.212	1	.302	1
.042	0	.087	0	.138	1	.213	1	.315	1
.042	1	.089	1	.139	1	.215	0	.365	1
.042	0	.090	0	.139	0	.215	1	.422	1
.042	0	.091	1	.140	1	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION # 68 NUMBER OF POINTS :281

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INSPECTION #69 NUMBER OF POINTS : 281

.007	0	.044	0	.094	1	.142	1	.236	1
.007	0	.045	0	.094	1	.144	1	.238	1
.010	0	.046	1	.095	1	.144	0	.238	0
.011	0	.047	0	.095	0	.145	1	.240	1
.012	0	.047	0	.096	0	.145	1	.240	1
.012	0	.048	0	.097	1	.147	0	.242	1
.012	0	.050	0	.098	0	.147	1	.242	1
.013	0	.050	1	.098	0	.147	1	.242	1
.013	0	.051	0	.100	1	.148	1	.243	0
.014	0	.052	0	.100	1	.148	1	.245	1
.014	0	.054	1	.100	1	.148	1	.245	1
.015	0	.057	1	.102	1	.148	1	.247	0
.015	0	.057	1	.102	1	.150	1	.247	1
.016	0	.057	0	.102	1	.150	1	.248	1
.016	0	.057	0	.103	0	.152	1	.249	1
.017	0	.057	1	.104	1	.152	1	.250	1
.017	0	.059	0	.105	1	.152	0	.250	1
.018	1	.060	0	.105	0	.153	1	.252	0
.019	0	.060	0	.105	1	.153	1	.252	1
.019	0	.060	0	.106	1	.153	0	.254	1
.020	0	.062	1	.107	1	.154	1	.255	1
.020	0	.062	0	.107	1	.155	1	.255	1
.020	0	.063	1	.110	1	.155	1	.255	1
.020	0	.065	0	.113	1	.156	1	.255	1
.021	0	.065	1	.114	1	.163	1	.256	0
.021	0	.065	0	.115	1	.163	1	.256	1
.022	0	.066	1	.115	0	.165	1	.257	1
.022	0	.066	1	.117	0	.172	0	.257	0
.022	0	.067	0	.118	1	.173	1	.257	1
.023	0	.068	1	.118	0	.173	1	.260	1
.023	0	.070	0	.118	1	.175	1	.260	1
.025	0	.070	0	.118	1	.177	1	.261	0
.026	1	.070	1	.119	1	.179	1	.262	1
.026	0	.072	0	.121	1	.180	1	.262	1
.026	0	.072	1	.122	1	.180	0	.262	0
.027	1	.072	1	.122	1	.183	1	.263	1
.027	0	.073	1	.123	1	.190	1	.265	1
.032	0	.073	0	.125	1	.191	1	.265	1
.033	0	.073	0	.125	1	.192	0	.270	1
.034	1	.077	1	.126	1	.192	1	.270	1
.035	0	.077	1	.127	1	.197	0	.272	1
.035	0	.080	0	.128	1	.197	1	.272	1
.035	0	.080	0	.130	0	.200	1	.273	1
.036	0	.080	0	.130	1	.200	0	.275	1
.037	0	.081	0	.132	1	.201	0	.275	0
.038	1	.082	0	.132	0	.203	1	.278	1
.039	0	.084	0	.132	0	.205	1	.280	1
.040	1	.086	1	.135	0	.206	0	.298	1
.040	0	.087	0	.135	1	.208	1	.300	1
.041	0	.087	1	.136	0	.212	1	.302	1
.042	0	.087	0	.138	1	.213	1	.315	0
.042	0	.089	1	.139	1	.215	0	.365	0
.042	0	.090	0	.139	0	.215	1	.422	1
.042	0	.091	0	.140	0	.215	1		
.043	1	.092	1	.140	1	.222	1		
.043	0	.092	1	.140	1	.235	1		
.043	0	.093	1	.142	1	.236	1		

INSPECTION # 70

NUMBER OF POINTS :281

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INSPECTION #71 NUMBER OF POINTS :281

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.422	1

INSPECTION # 72 NUMBER OF POINTS :281

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.422	1

INSPECTION #73

NUMBER OF POINTS :284

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.010	0
.011	0
.012	0
.012	0
.015	0
.016	0
.018	0
.018	0
.019	0
.020	0
.020	0
.021	0
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.025	0
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.026	0
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.301	1
.310	1
.315	1
.330	1
.347	0
.350	1

INSPECTION #74 NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	1	.091	1	.133	1	.228	1
.011	0	.048	0	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	0	.231	1
.015	1	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	1	.052	1	.095	0	.135	1	.234	0
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	0	.138	0	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	0	.100	0	.140	1	.241	1
.026	0	.057	1	.102	0	.140	1	.242	1
.028	0	.058	0	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	0	.060	1	.105	0	.141	1	.245	1
.030	1	.060	1	.105	1	.145	1	.245	1
.031	0	.063	1	.105	1	.145	1	.245	1
.032	1	.063	1	.106	0	.146	1	.246	1
.035	0	.063	1	.107	0	.147	0	.246	1
.035	0	.064	1	.107	0	.147	1	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	1	.067	0	.111	1	.150	1	.248	1
.035	1	.070	1	.111	0	.151	1	.248	1
.036	0	.070	1	.112	1	.151	0	.250	1
.036	1	.071	0	.115	1	.152	1	.250	0
.038	0	.071	1	.115	1	.152	1	.250	1
.038	0	.073	1	.116	1	.165	1	.252	0
.038	0	.075	1	.117	1	.167	1	.256	1
.038	1	.075	0	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	0	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	1
.040	1	.077	0	.122	1	.185	1	.265	0
.040	1	.078	1	.122	1	.185	1	.265	0
.040	1	.078	0	.122	1	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	1	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	1	.081	0	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	0	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	0	.222	1	.330	1
.045	1	.085	1	.130	0	.223	1	.347	1
.045	1	.085	1	.130	0	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION #75 **NUMBER OF POINTS :284**

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	1	.090	1	.133	1	.228	1
.010	0	.047	0	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	1	.135	1	.231	1
.015	0	.049	1	.095	1	.135	1	.232	1
.016	0	.050	1	.095	1	.135	0	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	0	.052	1	.095	0	.135	1	.234	1
.019	1	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	1
.020	0	.054	1	.097	1	.136	1	.236	1
.021	0	.055	1	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	1	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	0	.240	1
.025	1	.056	0	.100	1	.138	1	.240	1
.025	1	.057	1	.100	0	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	1	.058	1	.103	1	.140	1	.242	1
.028	1	.060	1	.105	1	.141	1	.243	1
.030	0	.060	1	.105	0	.141	1	.245	1
.030	1	.060	1	.105	1	.145	1	.245	1
.031	1	.063	1	.105	0	.145	1	.245	1
.032	1	.063	1	.106	1	.146	1	.246	1
.035	0	.063	1	.107	0	.147	0	.246	1
.035	1	.064	1	.107	0	.147	1	.246	1
.035	0	.065	1	.111	1	.149	1	.248	1
.035	1	.067	1	.111	1	.150	1	.248	1
.035	1	.070	1	.111	1	.151	1	.248	1
.036	0	.070	1	.112	1	.151	0	.250	1
.036	1	.071	0	.115	1	.152	1	.250	0
.038	1	.071	1	.115	1	.152	1	.250	1
.038	1	.073	1	.116	1	.165	1	.252	1
.038	1	.075	1	.117	1	.167	1	.256	1
.038	1	.075	1	.118	1	.170	1	.260	1
.038	1	.076	1	.120	1	.170	1	.260	0
.039	0	.076	1	.120	1	.180	1	.262	1
.040	1	.077	0	.121	1	.180	1	.262	0
.040	1	.077	0	.122	1	.185	1	.265	1
.040	1	.078	1	.122	1	.185	1	.265	1
.040	1	.078	1	.122	0	.190	1	.268	1
.040	1	.080	1	.123	1	.190	1	.268	1
.040	0	.080	1	.123	1	.192	1	.270	1
.041	1	.080	1	.123	1	.200	1	.270	1
.042	1	.080	1	.125	1	.204	1	.283	1
.042	1	.080	1	.126	1	.211	1	.285	1
.042	0	.080	0	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	1	.081	1	.130	1	.216	1	.310	1
.043	1	.082	1	.130	1	.220	1	.315	1
.045	0	.085	1	.130	1	.222	1	.330	1
.045	0	.085	1	.130	0	.223	1	.347	1
.045	1	.085	0	.130	0	.225	1	.350	1
.045	1	.086	1	.130	1	.226	1		

INSPECTION #76 **NUMBER OF POINTS : 72**

.010	0
.012	0
.020	0
.025	1
.025	1
.028	1
.030	1
.035	1
.038	1
.038	1
.038	1
.039	1
.040	1
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.045	1
.050	1
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.067	1
.070	1
.073	1
.078	1
.085	1
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.245	1
.246	1
.270	1
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.301	1
.310	1
.350	1

INSPECTION #77

NUMBER OF POINTS : 68

.022	0
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.032	0
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.036	1
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.040	1
.043	-1
.045	1
.045	0
.049	1
.052	1
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.057	-1
.058	0
.060	1
.065	0
.070	1
.071	1
.071	1
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.076	1
.077	1
.080	1
.082	1
.094	1
.095	0
.097	1
.105	0
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.116	1
.120	1
.123	1
.130	1
.133	1
.133	1
.134	1
.136	1
.137	1
.138	0
.138	1
.140	1
.146	-1
.212	1
.225	1
.226	1
.227	1
.228	1
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.233	1
.234	1
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.245	1
.245	1
.250	1
.270	1

INSPECTION #78

NUMBER OF POINTS : 71

.005	0
.008	0
.010	0
.022	1
.025	-1
.025	1
.030	1
.031	0
.032	1
.035	1
.035	1
.035	1
.036	1
.040	1
.040	1
.043	-1
.045	1
.045	1
.049	1
.052	1
.053	1
.055	1
.055	1
.057	-1
.058	1
.060	1
.065	1
.070	1
.071	1
.071	1
.075	1
.075	-1
.076	1
.077	1
.080	1
.082	1
.094	1
.095	1
.097	1
.105	1
.105	1
.111	1
.111	-1
.115	1
.116	1
.120	1
.123	1
.130	1
.133	1
.133	1
.134	1
.136	1
.137	1
.138	1
.138	1
.140	1
.146	-1
.212	1
.225	1
.226	1
.227	1
.228	1
.231	1
.233	1
.234	1
.240	1
.243	1
.245	1
.245	1
.250	1
.270	1

INSPECTION #79 (CRACK LENGTH) NUMBER OF POINTS :284

.008	0	.045	0	.087	1	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	0	.090	1	.133	1	.228	1
.010	0	.047	1	.091	0	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	1
.012	0	.049	0	.094	1	.134	0	.230	1
.012	0	.049	0	.095	1	.135	1	.231	1
.015	0	.049	0	.095	0	.135	1	.232	1
.016	0	.050	0	.095	1	.135	1	.233	1
.018	0	.050	1	.095	1	.135	1	.233	1
.018	0	.052	0	.095	1	.135	1	.234	1
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	1	.097	1	.136	1	.236	0
.020	0	.054	0	.097	1	.136	1	.236	1
.021	0	.055	0	.098	1	.137	1	.237	1
.022	0	.055	1	.098	1	.137	1	.237	1
.025	0	.055	0	.099	1	.137	1	.240	1
.025	0	.055	0	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	0	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	0	.058	0	.103	1	.140	1	.242	1
.028	0	.060	1	.105	1	.141	1	.243	1
.030	0	.060	0	.105	0	.141	1	.245	1
.030	0	.060	0	.105	1	.145	1	.245	1
.031	0	.063	0	.105	1	.145	1	.245	1
.032	1	.063	0	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	0	.064	1	.107	1	.147	1	.246	1
.035	0	.065	0	.111	1	.149	1	.248	1
.035	0	.067	0	.111	1	.150	1	.248	1
.035	0	.070	1	.111	1	.151	1	.248	1
.036	0	.070	0	.112	1	.151	1	.250	1
.036	0	.071	0	.115	1	.152	1	.250	1
.038	0	.071	1	.115	1	.152	1	.250	1
.038	0	.073	1	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	1	.118	1	.170	1	.260	1
.038	0	.076	0	.120	0	.170	1	.260	1
.039	0	.076	0	.120	1	.180	1	.262	1
.040	0	.077	1	.121	0	.180	1	.262	1
.040	0	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.190	1	.268	1
.040	0	.080	1	.123	1	.190	1	.268	1
.040	0	.080	1	.123	1	.192	1	.270	1
.041	0	.080	1	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	0	.080	1	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	0	.081	1	.127	1	.214	1	.301	1
.043	0	.081	1	.130	1	.216	1	.310	1
.043	0	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	0	.085	0	.130	1	.223	1	.347	1
.045	0	.085	0	.130	1	.225	1	.350	1
.045	0	.086	1	.130	1	.226	1		

INSPECTION #79 (CRACK DEPTH) NUMBER OF POINTS : 284

.001	0	.009	0	.015	0	.025	1	.049	1
.002	0	.009	0	.015	1	.026	1	.050	1
.002	0	.009	0	.015	1	.026	1	.050	1
.002	0	.009	0	.016	1	.026	1	.050	1
.002	0	.009	0	.016	1	.026	1	.050	1
.002	0	.009	0	.016	1	.027	1	.050	1
.002	0	.009	0	.016	1	.027	1	.051	1
.003	0	.009	0	.016	0	.027	1	.053	1
.003	0	.010	0	.016	1	.027	1	.053	1
.003	0	.010	1	.016	1	.027	0	.053	1
.003	0	.010	1	.016	1	.027	1	.054	1
.004	0	.010	0	.016	1	.028	1	.054	1
.004	0	.010	0	.016	1	.028	1	.054	1
.004	0	.010	0	.016	1	.028	1	.054	1
.004	0	.010	1	.016	0	.029	1	.055	1
.004	0	.010	1	.016	0	.029	1	.055	1
.005	0	.010	1	.016	1	.030	1	.055	1
.005	0	.010	1	.016	1	.030	1	.055	1
.005	0	.011	0	.017	1	.030	0	.056	1
.005	0	.011	0	.017	1	.030	1	.056	1
.005	0	.011	1	.017	1	.031	1	.057	1
.005	0	.011	1	.017	1	.031	1	.057	1
.005	0	.011	0	.017	1	.031	1	.058	1
.006	0	.011	0	.017	1	.031	1	.058	1
.006	0	.011	0	.017	1	.031	1	.058	1
.006	0	.011	1	.017	1	.032	1	.058	1
.006	0	.011	0	.017	1	.032	1	.059	1
.006	1	.011	0	.017	1	.032	1	.059	1
.007	0	.012	0	.018	1	.032	1	.060	1
.007	0	.012	1	.018	1	.034	1	.060	1
.007	0	.012	0	.018	1	.034	1	.060	1
.007	1	.012	0	.018	0	.034	1	.060	1
.007	0	.012	0	.019	0	.034	1	.061	1
.007	0	.012	1	.019	1	.035	1	.061	1
.007	0	.012	1	.019	1	.035	1	.061	1
.007	0	.013	0	.020	1	.035	1	.062	1
.007	0	.013	1	.020	1	.035	1	.062	1
.007	0	.013	0	.020	1	.036	1	.062	1
.007	0	.013	0	.020	1	.037	1	.063	1
.007	0	.013	1	.020	1	.039	1	.063	1
.007	0	.013	1	.020	1	.040	1	.063	1
.007	0	.013	1	.021	1	.041	1	.063	1
.008	0	.013	1	.022	1	.041	1	.064	1
.008	0	.014	1	.022	1	.044	1	.064	1
.008	0	.014	1	.022	1	.044	1	.064	1
.008	0	.014	1	.022	1	.045	1	.065	1
.008	0	.014	1	.022	1	.045	1	.065	1
.008	0	.014	1	.022	1	.046	1	.065	1
.008	0	.014	0	.023	1	.046	1	.065	1
.008	0	.014	1	.023	1	.046	1	.066	1
.008	0	.014	1	.023	1	.047	1	.067	1
.008	0	.014	0	.023	1	.047	1	.067	1
.008	0	.014	1	.023	1	.047	1	.067	1
.008	0	.014	1	.023	1	.048	0	.067	1
.009	1	.014	1	.024	1	.049	1	.067	1
.009	0	.015	1	.024	1	.049	1	.069	1
.009	0	.015	1	.024	1	.049	1		

INSPECTION #80 (CRACK LENGTH) NUMBER OF POINTS :284

.008	0	.045	0	.087	0	.130	1	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	0	.090	1	.133	1	.228	1
.010	0	.047	0	.091	0	.133	1	.228	1
.011	0	.048	0	.091	1	.133	1	.229	1
.012	0	.048	0	.094	1	.134	1	.230	1
.012	0	.049	0	.095	0	.135	1	.231	1
.015	0	.049	0	.096	1	.135	1	.232	1
.016	0	.050	0	.096	0	.135	0	.233	1
.018	0	.050	0	.096	1	.135	1	.233	1
.018	0	.052	0	.096	0	.135	1	.234	1
.019	0	.052	0	.097	1	.135	1	.234	1
.020	0	.053	1	.097	0	.136	1	.236	1
.020	0	.054	0	.097	1	.136	1	.236	1
.021	0	.055	0	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	0	.099	1	.137	1	.240	1
.025	0	.055	0	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	1	.100	0	.140	1	.241	1
.026	0	.057	1	.102	0	.140	1	.242	1
.028	0	.058	0	.103	1	.140	1	.242	1
.028	0	.060	1	.105	1	.141	1	.243	1
.030	0	.060	0	.105	0	.141	1	.245	1
.030	0	.060	0	.105	1	.145	1	.245	1
.031	0	.063	0	.105	1	.145	1	.245	1
.032	0	.063	0	.106	1	.146	1	.246	1
.035	0	.063	0	.107	1	.147	1	.246	1
.035	0	.064	0	.107	1	.147	1	.246	1
.035	0	.065	-1	.111	1	.149	1	.248	1
.035	0	.067	0	.111	-1	.150	1	.248	1
.035	0	.070	1	.111	1	.151	1	.248	1
.036	0	.070	0	.112	1	.151	1	.250	1
.036	0	.071	0	.115	1	.152	1	.250	1
.038	0	.071	1	.115	1	.152	1	.250	1
.038	0	.073	0	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	0	.076	0	.120	0	.170	1	.260	1
.039	0	.076	0	.120	1	.180	1	.262	1
.040	0	.077	0	.121	1	.180	1	.262	1
.040	0	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.190	1	.268	1
.040	0	.080	0	.123	1	.190	1	.268	1
.040	0	.080	-1	.123	1	.192	1	.270	1
.041	0	.080	0	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	0	.080	0	.126	1	.211	1	.285	1
.042	0	.080	1	.126	1	.212	1	.300	1
.043	0	.081	1	.127	1	.214	1	.301	1
.043	0	.081	0	.130	1	.216	1	.310	1
.043	0	.082	0	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	0	.085	0	.130	1	.223	1	.347	1
.045	1	.085	0	.130	1	.225	1	.350	1
.045	0	.086	1	.130	1	.226	1		

INSPECTION #80 (CRACK DEPTH) NUMBER OF POINTS :284

.001	0	.009	0	.015	0	.025	1	.049	1
.002	0	.009	1	.015	1	.026	1	.050	1
.002	0	.009	0	.015	1	.026	1	.050	1
.002	0	.009	0	.016	1	.026	1	.050	1
.002	0	.009	0	.016	1	.026	1	.050	1
.002	0	.009	0	.016	1	.027	1	.050	1
.002	0	.009	0	.016	1	.027	1	.051	1
.003	0	.009	0	.016	0	.027	1	.053	1
.003	0	.010	0	.016	0	.027	1	.053	1
.003	0	.010	0	.016	1	.027	1	.053	1
.003	0	.010	0	.016	1	.027	1	.054	1
.004	0	.010	0	.016	1	.028	1	.054	1
.004	0	.010	0	.016	0	.028	1	.054	1
.004	0	.010	0	.016	1	.028	1	.054	1
.004	0	.010	0	.016	0	.029	1	.055	1
.004	0	.010	-1	.016	0	.029	1	.055	1
.005	0	.010	0	.016	1	.030	1	.055	1
.005	0	.010	0	.016	1	.030	1	.055	1
.005	0	.011	0	.017	1	.030	1	.056	1
.005	0	.011	0	.017	-1	.030	1	.056	1
.005	0	.011	0	.017	1	.031	1	.057	1
.005	0	.011	1	.017	1	.031	0	.057	1
.005	0	.011	0	.017	1	.031	1	.058	1
.006	0	.011	0	.017	1	.031	1	.058	1
.006	0	.011	0	.017	0	.031	1	.058	1
.006	0	.011	0	.017	0	.032	1	.058	1
.006	0	.011	0	.017	1	.032	1	.059	1
.006	0	.011	0	.017	0	.032	1	.059	1
.007	0	.012	0	.018	1	.032	1	.060	1
.007	0	.012	1	.018	1	.034	1	.060	1
.007	0	.012	0	.018	1	.034	1	.060	1
.007	1	.012	0	.018	0	.034	1	.060	1
.007	0	.012	1	.019	0	.034	1	.061	1
.007	0	.012	1	.019	1	.035	1	.061	1
.007	0	.012	1	.019	1	.035	1	.061	1
.007	0	.013	0	.020	1	.035	1	.062	1
.007	0	.013	0	.020	1	.035	1	.062	1
.007	0	.013	1	.020	1	.036	1	.062	1
.007	0	.013	0	.020	0	.037	1	.063	1
.007	0	.013	0	.020	1	.039	1	.063	1
.007	0	.013	1	.020	1	.040	1	.063	1
.007	0	.013	0	.021	1	.041	1	.063	1
.008	0	.013	0	.022	1	.041	1	.064	1
.008	0	.014	1	.022	1	.044	1	.064	1
.008	0	.014	1	.022	1	.044	1	.064	1
.008	0	.014	1	.022	1	.045	1	.065	1
.008	-1	.014	1	.022	1	.045	1	.065	1
.008	0	.014	0	.022	1	.046	1	.065	1
.008	0	.014	0	.023	1	.046	1	.065	1
.008	0	.014	1	.023	1	.046	1	.066	1
.008	0	.014	1	.023	1	.047	1	.067	1
.008	0	.014	0	.023	1	.047	1	.067	1
.008	0	.014	1	.023	1	.047	1	.067	1
.008	0	.014	1	.023	1	.048	1	.067	1
.009	0	.014	0	.024	1	.049	1	.067	1
.009	0	.015	0	.024	1	.049	1	.069	1
.009	0	.015	0	.024	1	.049	1		

INSPECTION #81 (CRACK LENGTH) NUMBER OF POINTS :284

.008	0	.045	0	.087	1	.130	0	.227	1
.010	0	.046	0	.090	1	.132	1	.228	1
.010	0	.046	0	.090	1	.133	1	.228	1
.010	0	.047	0	.091	1	.133	1	.228	1
.011	0	.048	1	.091	1	.133	1	.229	0
.012	0	.048	1	.094	1	.134	1	.230	1
.012	0	.049	1	.095	0	.135	1	.231	1
.015	0	.049	1	.095	1	.135	1	.232	1
.016	0	.050	0	.095	1	.135	1	.233	1
.018	0	.050	0	.095	1	.135	1	.233	1
.018	0	.052	0	.095	1	.135	1	.234	1
.019	0	.052	1	.097	1	.135	1	.234	1
.020	0	.053	0	.097	0	.136	1	.236	1
.020	0	.054	0	.097	1	.136	1	.236	1
.021	0	.055	0	.098	1	.137	1	.237	1
.022	0	.055	0	.098	1	.137	1	.237	1
.025	0	.055	1	.099	1	.137	1	.240	1
.025	0	.055	1	.100	1	.138	1	.240	1
.025	0	.056	0	.100	1	.138	1	.240	1
.025	0	.057	0	.100	1	.140	1	.241	1
.026	0	.057	1	.102	1	.140	1	.242	1
.028	0	.058	1	.103	1	.140	1	.242	1
.028	0	.060	1	.105	1	.141	1	.243	1
.030	0	.060	0	.105	1	.141	1	.245	1
.030	0	.060	1	.105	1	.145	1	.245	1
.031	0	.063	0	.105	1	.145	1	.245	1
.032	0	.063	0	.106	1	.146	1	.246	1
.035	0	.063	1	.107	1	.147	1	.246	1
.035	0	.064	1	.107	1	.147	1	.246	1
.035	0	.065	-1	.111	1	.149	1	.248	1
.035	0	.067	0	.111	-1	.150	1	.248	1
.035	0	.070	1	.111	1	.151	1	.248	1
.036	0	.070	0	.112	1	.151	1	.250	1
.036	0	.071	1	.115	1	.152	1	.250	1
.038	0	.071	1	.115	1	.152	1	.250	1
.038	0	.073	1	.116	1	.165	1	.252	1
.038	0	.075	1	.117	1	.167	1	.256	1
.038	0	.075	0	.118	1	.170	1	.260	1
.038	0	.076	1	.120	1	.170	1	.260	1
.039	0	.076	1	.120	1	.180	1	.262	1
.040	0	.077	1	.121	1	.180	1	.262	1
.040	0	.077	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.185	1	.265	1
.040	0	.078	1	.122	1	.190	1	.268	1
.040	0	.080	1	.123	1	.190	1	.268	1
.040	0	.080	-1	.123	1	.192	1	.270	1
.041	0	.080	1	.123	1	.200	1	.270	1
.042	0	.080	1	.125	1	.204	1	.283	1
.042	0	.080	1	.126	1	.211	1	.285	1
.042	1	.080	0	.126	1	.212	1	.300	1
.043	1	.081	1	.127	1	.214	1	.301	1
.043	0	.081	1	.130	1	.216	1	.310	1
.043	0	.082	1	.130	1	.220	1	.315	1
.045	0	.085	0	.130	1	.222	1	.330	1
.045	0	.085	1	.130	0	.223	1	.347	1
.045	0	.085	1	.130	1	.225	1	.350	1
.045	0	.086	0	.130	1	.226	1		

INSPECTION #81 (CRACK DEPTH) NUMBER OF POINTS :284

.001	0	.009	0	.015	1	.025	1	.049	1
.002	0	.009	0	.015	1	.026	1	.050	1
.002	0	.009	1	.015	1	.026	1	.050	1
.002	0	.009	0	.016	1	.026	1	.050	1
.002	0	.009	0	.016	1	.026	1	.050	1
.002	0	.009	0	.016	1	.027	1	.050	1
.002	0	.009	0	.016	1	.027	1	.051	1
.003	0	.009	0	.016	1	.027	1	.053	1
.003	0	.010	1	.016	1	.027	1	.053	1
.003	0	.010	1	.016	1	.027	1	.053	1
.003	0	.010	1	.016	1	.027	1	.054	1
.004	0	.010	1	.016	1	.028	1	.054	1
.004	0	.010	1	.016	0	.028	1	.054	1
.004	0	.010	0	.016	1	.028	1	.054	1
.004	0	.010	1	.016	1	.029	1	.055	1
.004	0	.010	-1	.016	1	.029	0	.055	1
.005	0	.010	0	.016	1	.030	1	.055	1
.005	0	.010	1	.016	1	.030	1	.055	1
.005	0	.011	0	.017	1	.030	1	.056	1
.005	0	.011	0	.017	-1	.030	1	.056	1
.005	0	.011	0	.017	1	.031	1	.057	1
.005	0	.011	0	.017	1	.031	1	.057	1
.005	0	.011	0	.017	1	.031	1	.058	1
.006	0	.011	0	.017	1	.031	1	.058	1
.006	0	.011	1	.017	1	.031	1	.058	1
.006	0	.011	1	.017	1	.032	1	.058	1
.006	0	.011	1	.017	0	.032	1	.059	1
.006	0	.011	1	.017	1	.032	1	.059	1
.007	0	.012	1	.018	1	.032	1	.060	1
.007	0	.012	1	.018	1	.034	1	.060	1
.007	0	.012	1	.018	0	.034	1	.060	1
.007	1	.012	1	.018	1	.034	1	.060	1
.007	0	.012	0	.019	1	.034	1	.061	1
.007	0	.012	1	.019	1	.035	1	.061	1
.007	0	.012	1	.019	1	.035	1	.061	1
.007	0	.013	0	.020	1	.035	1	.062	1
.007	0	.013	0	.020	1	.035	1	.062	1
.007	0	.013	1	.020	1	.036	1	.062	1
.007	0	.013	0	.020	1	.037	1	.063	1
.007	0	.013	1	.020	1	.039	1	.063	1
.007	0	.013	1	.020	1	.040	1	.063	1
.007	0	.013	1	.021	1	.041	1	.063	1
.008	0	.013	1	.022	1	.041	1	.064	1
.008	0	.014	1	.022	1	.044	1	.064	1
.008	0	.014	1	.022	1	.044	1	.064	1
.008	0	.014	1	.022	0	.045	1	.065	1
.008	-1	.014	1	.022	1	.045	1	.065	1
.008	0	.014	0	.022	1	.046	1	.065	1
.008	0	.014	0	.023	1	.046	1	.065	1
.008	0	.014	1	.023	1	.046	0	.066	1
.008	0	.014	1	.023	1	.047	1	.067	1
.008	0	.014	0	.023	1	.047	1	.067	1
.008	0	.014	1	.023	1	.047	1	.067	1
.008	1	.014	1	.023	1	.048	1	.067	1
.009	0	.014	1	.024	1	.049	1	.067	1
.009	0	.015	1	.024	1	.049	1	.069	1
.009	0	.015	1	.024	1	.049	1		

INSPECTION #82 (CRACK LENGTH) NUMBER OF POINTS :284

.008	0	.045	0	.087	8	.130	53	.227	101
.010	0	.046	0	.090	15	.132	55	.228	101
.010	0	.046	0	.090	18	.133	42	.228	72
.010	0	.047	0	.091	0	.133	65	.228	96
.011	0	.048	0	.091	19	.133	31	.229	101
.012	0	.048	0	.094	35	.134	15	.230	101
.012	0	.049	0	.095	2	.135	37	.231	101
.015	0	.049	0	.095	16	.135	57	.232	101
.016	0	.050	0	.095	18	.135	53	.233	101
.018	0	.050	0	.095	18	.135	66	.233	101
.018	0	.052	0	.095	22	.135	58	.234	97
.019	0	.052	7	.097	21	.135	50	.234	101
.020	0	.053	0	.097	27	.136	57	.236	101
.020	0	.054	3	.097	16	.136	39	.236	60
.021	0	.055	0	.098	22	.137	26	.237	100
.022	0	.055	4	.098	15	.137	40	.237	14
.025	0	.055	0	.099	23	.137	45	.240	101
.025	0	.055	0	.100	33	.138	42	.240	101
.025	0	.056	0	.100	12	.138	36	.240	101
.025	0	.057	0	.100	15	.140	68	.241	101
.026	0	.057	0	.102	33	.140	47	.242	82
.028	0	.058	0	.103	23	.140	72	.242	101
.028	0	.060	13	.105	11	.141	32	.243	101
.030	0	.060	0	.105	6	.141	48	.245	101
.030	0	.060	9	.105	39	.145	60	.245	101
.031	0	.063	0	.105	34	.145	67	.245	101
.032	0	.063	0	.106	16	.146	52	.246	58
.035	0	.063	6	.107	24	.147	66	.246	101
.035	0	.064	0	.107	31	.147	67	.246	101
.035	0	.065	0	.111	27	.149	63	.248	101
.035	0	.067	5	.111	14	.150	25	.248	101
.035	0	.070	12	.111	21	.151	42	.248	72
.036	0	.070	0	.112	30	.151	75	.250	101
.036	0	.071	0	.115	38	.152	39	.250	101
.038	0	.071	15	.115	35	.152	48	.250	21
.038	0	.073	0	.116	34	.165	65	.252	101
.038	0	.075	15	.117	36	.167	101	.256	101
.038	0	.075	0	.118	28	.170	92	.260	101
.038	0	.076	10	.120	32	.170	95	.260	96
.039	0	.076	8	.120	50	.180	97	.262	101
.040	0	.077	14	.121	43	.180	101	.262	101
.040	0	.077	15	.122	32	.185	101	.265	101
.040	0	.078	0	.122	45	.185	88	.265	101
.040	0	.078	11	.122	33	.190	84	.268	67
.040	0	.080	0	.123	17	.190	101	.268	101
.040	0	.080	9	.123	30	.192	87	.270	54
.041	0	.080	6	.123	28	.200	101	.270	101
.042	0	.080	13	.125	58	.204	101	.283	101
.042	0	.080	13	.126	28	.211	101	.285	101
.042	0	.080	4	.126	36	.212	101	.300	101
.043	0	.081	15	.127	44	.214	101	.301	101
.043	0	.081	9	.130	28	.216	101	.310	101
.043	0	.082	16	.130	42	.220	101	.315	101
.045	0	.085	0	.130	54	.222	16	.330	101
.045	0	.085	5	.130	16	.223	101	.347	101
.045	0	.085	3	.130	33	.225	93	.350	101
.045	0	.086	14	.130	46	.226	76		

INSPECTION #82 (CRACK DEPTH) NUMBER OF POINTS :284

.001	0	.009	0	.015	0	.025	35	.049	101
.002	0	.009	0	.015	15	.026	66	.050	101
.002	0	.009	0	.015	23	.026	52	.050	101
.002	0	.009	0	.016	24	.026	36	.050	58
.002	0	.009	0	.016	31	.026	28	.050	101
.002	0	.009	0	.016	11	.027	45	.050	101
.002	0	.009	0	.016	15	.027	42	.051	101
.003	0	.009	0	.016	6	.027	39	.053	101
.003	0	.010	0	.016	14	.027	48	.053	101
.003	0	.010	0	.016	39	.027	43	.053	96
.003	0	.010	0	.016	15	.027	33	.054	101
.004	0	.010	0	.016	0	.028	36	.054	101
.004	0	.010	0	.016	0	.028	44	.054	101
.004	0	.010	0	.016	34	.028	58	.054	101
.004	0	.010	7	.016	10	.029	46	.055	67
.004	0	.010	9	.016	8	.029	53	.055	101
.005	0	.010	0	.016	11	.030	65	.055	101
.005	0	.010	6	.016	16	.030	55	.055	101
.005	0	.011	0	.017	27	.030	15	.056	54
.005	0	.011	0	.017	14	.030	31	.056	101
.005	0	.011	4	.017	15	.031	57	.057	16
.005	0	.011	0	.017	30	.031	53	.057	101
.005	0	.011	0	.017	21	.031	66	.058	72
.006	0	.011	3	.017	13	.031	58	.058	76
.006	0	.011	0	.017	13	.031	50	.058	96
.006	0	.011	8	.017	9	.032	68	.058	101
.006	0	.011	0	.017	4	.032	47	.059	101
.006	0	.011	5	.017	16	.032	36	.059	101
.007	0	.012	0	.018	38	.032	72	.060	101
.007	0	.012	15	.018	34	.034	60	.060	101
.007	0	.012	0	.018	14	.034	67	.060	101
.007	13	.012	9	.018	3	.034	97	.060	101
.007	0	.012	0	.019	32	.034	67	.061	60
.007	0	.012	19	.019	50	.035	75	.061	100
.007	0	.012	0	.019	18	.035	101	.061	14
.007	0	.013	0	.020	17	.035	63	.062	101
.007	0	.013	2	.020	30	.035	25	.062	101
.007	0	.013	16	.020	35	.036	84	.062	101
.007	0	.013	0	.020	22	.037	87	.063	101
.007	0	.013	18	.020	28	.039	65	.063	101
.007	0	.013	18	.020	32	.040	101	.063	101
.007	0	.013	0	.021	28	.041	92	.063	101
.008	0	.013	6	.022	28	.041	95	.064	101
.008	0	.014	22	.022	42	.044	101	.064	101
.008	0	.014	23	.022	54	.044	101	.064	72
.008	0	.014	12	.022	16	.045	88	.065	101
.008	0	.014	21	.022	42	.045	93	.065	101
.008	0	.014	27	.022	33	.046	101	.065	21
.008	0	.014	0	.023	57	.046	101	.065	101
.008	0	.014	15	.023	26	.046	101	.066	101
.008	0	.014	33	.023	40	.047	97	.067	101
.008	0	.014	5	.023	39	.047	101	.067	101
.008	0	.014	12	.023	45	.047	101	.067	101
.008	0	.014	16	.023	37	.048	101	.067	101
.009	0	.014	15	.024	32	.049	82	.067	101
.009	0	.015	0	.024	42	.049	101	.069	101
.009	0	.015	33	.024	48	.049	101		

INSPECTION #83

NUMBER OF POINTS :281

.007	0
.007	0
.010	0
.011	0
.012	0
.012	0
.012	0
.013	0
.013	0
.014	0
.014	0
.015	-1
.015	0
.016	0
.016	0
.017	-1
.017	0
.018	0
.019	0
.019	0
.020	0
.020	0
.020	0
.020	0
.021	0
.021	20
.022	0
.022	0
.022	0
.023	0
.023	0
.025	0
.026	0
.026	0
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.027	0
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.032	0
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.035	0
.035	0
.036	0
.037	0
.038	0
.039	0
.040	0
.040	0
.041	0
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.042	0
.042	0
.043	0
.043	0
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.044	0
.045	0
.046	0
.047	0
.047	0
.048	0
.050	0
.050	60
.051	0
.052	0
.054	85
.057	0
.057	10
.057	0
.057	0
.057	0
.059	0
.060	0
.060	0
.060	0
.062	0
.062	0
.063	0
.065	0
.065	35
.065	0
.066	-1
.066	0
.067	0
.068	45
.070	0
.070	0
.070	75
.072	0
.072	45
.072	0
.073	60
.073	0
.073	0
.077	0
.077	65
.080	0
.080	60
.080	0
.081	0
.082	30
.084	0
.086	20
.087	0
.087	40
.087	60
.089	45
.090	0
.091	0
.092	95
.092	95
.093	0
.094	60
.094	75
.095	95
.095	45
.036	35
.097	95
.098	60
.098	0
.100	75
.100	0
.100	95
.102	95
.102	0
.102	80
.103	40
.104	25
.105	95
.105	0
.105	95
.106	95
.107	0
.107	0
.110	0
.113	20
.114	85
.115	0
.115	20
.117	35
.118	95
.118	0
.118	20
.118	95
.119	95
.121	0
.122	-1
.122	0
.123	0
.125	80
.125	0
.126	0
.127	95
.128	95
.130	0
.130	95
.132	95
.132	0
.132	25
.135	30
.135	30
.136	45
.138	95
.139	90
.139	0
.140	70
.140	90
.140	50
.142	45
.142	95
.144	0
.144	30
.145	95
.145	95
.147	0
.147	75
.147	45
.148	95
.148	90
.148	95
.148	95
.150	95
.150	95
.152	95
.152	95
.152	50
.153	0
.153	95
.153	90
.154	95
.155	95
.155	95
.156	95
.163	95
.163	95
.165	95
.172	95
.173	-1
.173	0
.175	95
.177	95
.179	95
.180	95
.180	95
.183	95
.190	75
.191	95
.192	95
.192	95
.197	85
.197	95
.200	95
.200	95
.201	95
.203	95
.205	60
.206	95
.208	95
.212	95
.213	95
.215	95
.215	85
.215	95
.222	95
.235	95
.236	95
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.250	95
.252	95
.252	95
.254	95
.255	95
.255	95
.255	45
.255	95
.256	95
.256	0
.257	95
.257	95
.257	95
.260	0
.260	95
.261	75
.262	95
.262	95
.262	95
.263	95
.265	95
.265	95
.270	95
.270	95
.272	90
.272	95
.273	95
.275	95
.275	-1
.278	95
.280	95
.298	95
.300	95
.302	95
.315	95
.365	95
.422	95

INSPECTION #84

NUMBER OF POINTS :281

.007	0
.007	0
.010	0
.011	0
.012	0
.012	0
.012	0
.013	0
.013	-1
.014	0
.014	0
.015	0
.015	-1
.016	0
.016	-1
.017	0
.017	0
.018	0
.019	0
.019	0
.020	0
.020	0
.020	0
.020	0
.021	0
.021	-1
.022	0
.022	0
.022	0
.023	0
.023	0
.025	0
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.036	0
.037	0
.038	0
.039	0
.040	30
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.041	0
.042	0
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.044	20
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.046	0
.047	19
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.052	0
.054	90
.057	20
.057	55
.057	0
.057	0
.057	40
.059	0
.060	55
,060	0
.060	0
.062	0
.062	28
.063	70
.065	0
.065	40
.065	0
.066	100
.066	20
.067	0
.068	100
.070	85
.070	20
.070	100
.072	35
.072	100
.072	40
.073	-1
.073	20
.073	0
.077	100
.077	100
.080	0
.080	70
.080	50
.081	0
.082	20
.084	90
.086	70
.087	0
.087	100
.087	50
.089	100
.090	25
.091	100
.092	100
.092	100
.093	100
.094	100
.094	100
.095	100
.095	60
.096	0
.097	100
.098	20
.098	18
.100	100
.100	30
.100	100
.102	100
.102	80
.102	100
.103	35
.104	35
.105	100
.105	20
.105	100
.106	100
.107	60
.107	100
.110	100
.113	100
.114	100
.115	100
.115	70
.117	100
.118	100
.118	30
.118	80
.118	100
.119	100
.121	70
.122	100
.122	70
.123	40
.125	100
.125	100
.126	70
.127	100
.128	100
.130	30
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.135	100
.136	75
.138	100
.139	100
.139	30
.140	100
.140	100
.140	100
.142	100
.142	0
.144	80
.144	65
.145	100
.145	100
.147	60
.147	100
.147	100
.148	100
.148	100
.148	100
.148	100
.150	100
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.152	100
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.153	100
.153	100
.153	90
.154	100
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.156	100
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.177	100
.179	100
.180	100
.180	100
.183	100
.190	100
.191	100
.192	100
.192	100
.197	100
.197	100
.200	100
.200	100
.201	100
.203	-1
.205	100
.206	-1
.208	100
.212	100
.213	100
.215	100
.215	100
.215	100
.222	100
.235	100
.236	100
.236	100
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.242	100
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.265	100
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.273	100
.275	100
.275	100
.278	100
.280	100
.298	100
.300	100
.302	100
.315	100
.365	100
.422	100

INSPECTION #85

NUMBER OF POINTS :281

.007	0
.007	0
.010	0
.011	0
.012	0
.012	0
.012	0
.013	0
.013	-1
.014	0
.014	0
.015	0
.015	-1
.016	0
.016	-1
.017	0
.017	0
.018	0
.019	0
.019	0
.020	0
.020	0
.020	0
.020	0
.021	0
.021	-1
.022	0
.022	0
.022	0
.023	0
.023	0
.025	0
.026	0
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.041	0
.042	0
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.043	0
.044	20
.045	0
.046	0
.047	20
.047	0
.048	0
.050	0
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